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THE MANHATTAN ELEVATED RY. officials have offered to build extensions from the present termini at the Harlem River north to the city limits, and a cross-town connection between the lines via Canal and Center Sts. They also propose to build third tracks on all lines not already provided with them. Under what conditions these offers have been made is not made public.

THE DEVELOPMENT OF STATEN ISLAND as a residence district of New York is the purpose of several syndicates which propose to extend the electric railways, build new roads, put faster ferryboats on the New York line and establish new ferries to Elizabethport, Bayonne and Brooklyn. Two companies are already building electric railways extending back from the towns on the bay shore of the island. One of these is the Midland Electric Ry. Co., and the other is the Staten Island Electric Ry. Co., of which latter Col. G. B. M. Harvey is President.

THROUGH TRAINS OVER THE BROOKLYN BRIDGE are again proposed by the Brooklyn elevated railways. They propose to have the engines fitted with cable grips. The weight of a train is estimated at 48,000 lbs. for the engine, 125,000 lbs. for five cars, and 65,000 lbs. for 500 passengers, or 238,000 lbs. in all, the length of train being 258.95 ft. The weight of the cable trains is given as 50,000 lbs. for a car equipped with electric motors for switching, 120,000 lbs. for three cars and 65,000 lbs. for 500 passengers, or 241,000 lbs., the length of the four-car train being 200 ft.

CAST-IRON CAR WHEELS are not permitted to be used in any country of continental Europe with the exception of Austria, the laws to this effect having originated at a time when such wheels were very imperfect. This arbitrary action of course prevented any improvement in such wheels, while their general use in the United States has led to great improvements in the design and manufacture of the wheels, and the establishment of a large and important industry. During the past year Mr. Fr. von Emperger, consulting engineer, of New York city, representative of the Austrian government, was requested to investigate and report upon American practice. As a result of this, the Austrian Government Railways placed an order with the New York Car Wheel Works, of Buffalo, N. Y., for 120 standard cast-iron Griffin car wheels for use on freight cars fitted with brakes. These have been delivered, but the cars cannot be used beyond the Austrian frontiers, in consequence of a rule of the German Railway Union (which comprises all the states adjoining Austria) which forbids the use of brakes with cast-iron wheels. Should this experience on Austrian railways lead to the abolition of this rule there would be a good prospect for an export trade in this country, as the experience, machinery and skilled labor necessary for the construction of high grade cast-iron wheels cannot be had anywhere in Europe.

THE TRACK ELEVATION PLANS prepared by Mr. A. P. Boller, M. Am. Soc. C. E., for the city of Newark, N. J., have received the approval of the Central R. R. of New Jersey and the Pennsylvania R. R.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of the northbound New York express on the Florida Central & Peninsular R. R., which was thrown from the track at Anderson, Ga., May 11, by a switch which had been forced open by train wreckers, the target indicating that the switch was closed. The engine remained on the roadway, but all the cars went down the bank. The train consisted of two day cars, a smoking car, a combination mail and baggage car and a Pullman sleeping car. One passenger was killed and about 25 persons were injured, some seriously.——Another serious accident was the derailment of an express train in the yards of the Park Square terminus of the New York, New Haven & Hartford R. R., at Boston, Mass., May 7. The train was approaching the station when the first day car mounted the rails at a switch and was overturned, while the following cars left the rails. Two passengers were killed and two injured.

A STONE BRIDGE COLLAPSED at Cohoes, N. Y., May 8, while being torn down, and the foreman in charge of the work was drowned. The bridge crossed the Cohoes Co.'s canal and had been condemned.

THE EXPLOSION OF THE BOILERS of the towboat "Harry Brown," while hauling 60 empty barges up the Mississippi, 25 miles south of Vicksburg, Miss., on May 10, caused the sinking of the vessel and the loss of eleven lives.

THE YOUNG TRAIN WRECKERS who caused the fatal derailment on the New York Central R. R., at Rome, N. Y., on Nov. 19, 1895 (Eng. News, Nov. 28, 1895), have received heavy sentences. One has been sentenced to imprisonment for life and the other two to imprisonment for 40 years. The sentences are by no means too heavy for the offense, and it is to be hoped that they will stand, and will serve as a warning to other youths of similar character.

AN OFFICE BUILDING 21 STORIES HIGH is to be erected by Mr. J. J. Astor, at 94 Broadway and 5 Pine St., which will enclose the American Surety Building on the south and east sides. The latter building has all four fronts alike, and at present rises like a huge square white tower. The plans for the new building (which will be on the site of the Schermerhorn Building) have been prepared by Purdy & Henderson, of New York, and call for a structure about 300 ft. high, having a frontage of 38 ft. 5 ins. on Broadway, and 41 ft. 1 in. on Pine St. The foundations are to be carried to rock by means of pneumatic caissons.

DEEPENING THE NEW YORK HARBOR ENTRANCE to 35 ft. at mean low water was recommended by the New York Chamber of Commerce at its annual meeting. The large transatlantic liners now entering the port draw 30 ft. when fully loaded, and allowing for the settling of the stern of the vessel when under way and the effect of the wind in lowering the water surface at times, it is considered that 35 ft. is none too great. At present several of the largest vessels have to choose a favorable tide to go over the bar.

THE GREATER NEW YORK BILL is now a law, having been signed on May 11. The act provides for the consolidation of Brooklyn, Long Island City, Staten Island and portions of Kings and Queens counties with the city of New York to take effect on Jan. 1, 1898. A commission is to be appointed to prepare a charter for the enlarged city, which will have to meet the approval of the legislature before the consolidation can be actually effected.

COMPETITIVE ESSAYS on "The Progress of Invention During the Past Fifty Years," are invited by the "Scientific American," of New York, the prize paper to be published in its special number on July 5, commemorating the fiftieth anniversary of that journal. The prize offered is $250.

THE NEW CRUISER "BROOKLYN," on her builders' trial trip on May 11, made a speed of 21.07 knots on a three hours' run under forced draft. The speed requirement of the contract was 20 knots. The steam pressure was 155 lbs., and the revolutions of the screw 132 per minute. The cruiser "New York," which is of the same class as the "Brooklyn," made 20.08 knots on her builders' trial and 21.01 knots on her official trial.

THE NEW BATTLESHIP "OREGON" developed a speed of 16 knots in the recent trial trip at San Francisco. The guaranteed contract speed was 15 knots. The vessel was built by the Union Iron Works, of San Francisco.

THE BATTLESHIP "MASSACHUSETTS," in her official trial run of April 25, made an average speed of 16.20 knots for four continuous hours; the contract speed is 15 knots, and the "Indiana," her sister ship, made only 15.61 knots on her official trial. The weather conditions and the sea were perfect for the test and for a distance of over 6 knots a speed of 17.3 knots was reached. The maximum revolutions of the screw were 138 and the steam-pressure ranged from 150 to 165 lbs. The maximum I. HP. called for in the contract is 9,000; but enough is known to say that it exceeded 10,000 I. HP. during the trial. The "Massachusetts," built by Wm. Cramp & Sons, at Philadelphia, was contracted for on June 30, 1890, for $3,020,000. She is 348 ft. long, 63 ft. 3 in. beam, 24 ft. mean draft and has a displacement of 10,288 tons. The engines are of the twin screw vertical triple-expansion type. Her main battery contains four 13-in., eight 8-in. and four 6-in. breech-loading rifles, with 20 6-pdr. and six 1-pdr. rapid-fire guns and four Gatling guns in her secondary battery. She has six torpedo tubes and the armor is 18 ins. thick on her sides, 15 ins. and 6 ins. on her turrets and 17 ins., 8 ins. and 6 ins. on her barbettes, with a 2½-in. protective deck.

THE TURRET OF THE BATTLESHIP "MASSACHUsetts" was tested at the proving ground at Indian Head on May 9 to determine whether the structure would properly support the armor when it was struck a heavy blow from a projectile. The turret was placed on large steel cylinders representing the rollers upon which it rests when aboard ship. A 10-in. 500-lb. shot, with a velocity of 1,700 ft. per second penetrated the armor 6 ins. and broke up, leaving the framing practically uninjured. A 12-in. shot with the same velocity cracked the armor plate from top to bottom, but did only slight injury to the framing. The entire turret moved 7 ins. in the direction of the line of fire. A 12-in. shot with a velocity of 2,000 ft. per second penetrated the armor plate, the backing and the structure, passing entirely through the turret and breaking up on the cast-iron plate on the opposite side. The results show that the turret furnishes good protection to the guns and mounts within it as long as the armor is not actually penetrated.

A 15-IN. ARMOR PLATE, 17 × 9 ft., weighing 38 tons, for the battleship "Iowa," was tested at the Bethlehem Iron Co.'s proving grounds, May 5, by a shot from a 10-in. gun. A Carpenter projectile, weighing 500 lbs., was used, with a charge of 154 lbs. of powder. The shot struck near the center of the plate and was shattered, the point being imbedded and welded in the plate, and the plate was split across its width. The splitting is said to have been the result of a flaw which had previously caused the rejection of the plate.

DAMAGES FOR THE POLLUTION of a stream by tannery refuse were awarded last week by a Pennsylvania court to R. P. McFarland. The amount of the award was $425, and it was made against W. D. Byron & Sons, of Mercersburg, Pa.

A 66-IN. STEEL WATER SUPPLY CONDUIT or two 48-in. cast-iron conduits are under consideration by Mr. Theo. B. Willis, Commissioner of City Works, Brooklyn, N. Y. The conduit or conduits would be about 15 miles long and would connect newly-developed sources of supply with the main pumping station at Ridgewood. It is thought that by May 25 a call for proposals may be issued. A 15,000,000 and 3,000,000-gallon pumping engine are also under consideration.

A CONTRACT FOR A 20,000,000-GALLON DRIVEN well water supply for the city of Camden, N. J., has been awarded to Geo. Pfeiffer, Camden, N. J., for $525,000, the work to be completed within one year. The contract includes driven wells, a fully equipped pumping station, force mains and a stand-pipe. The only other formal bid was from the Wagner Well Supply Co., Dayton, O., who bid $541,000.

A NOVEL ARCHITECTURAL COMPETITION has been instituted by the Mississippi legislature, the chief feature of which is that there is no offer of prizes in connection with it. The text of the resolution establishing this competition is as follows:

Resolved, That the Governor of the state, Attorney General and Secretary of State be and they are hereby appointed a committee of three whose duty it shall be to procure by advertising or otherwise, plans and specifications for a Capitol building suitable for the needs of the state, to cost not less than $550,000 nor more than $1,000,000. That the plans and specifications adopted and used in the erection of the State House shall be paid for in a sum not to exceed $1,000, and should the architect drawing the same be engaged to supervise the erection of said house, then there is to be no compensation for said plans and specifications, and in no case shall there be any compensation for plans and specifications not adopted and used, and the said committee shall meet within 60 days after the adjournment of the legislature and collate all plans and information obtained by them that would be useful to the legislature in letting a contract for the erection of a new State House and report same fully at the next sitting of the legislaure.

In a circular which the committee is sending out, it announces that it will meet on July 15 to "collate all plans and information obtained by them to that date." In the meantime they announce that "they will be pleased to confer personally with such architects as may prefer to visit Jackson previous to the preparation of plans."

If the above correctly indicates the liberal sentiments of the Mississippi legislators toward architects, the architect must be very, very hard up who will venture to prepare plans in response to such a call. We venture the surmise that the number of architects who will lay out the car fare to visit Jackson as a preliminary to preparing plans will not be large.

A PNEUMATIC STREET SWEEPING MACHINE.

One of the most novel street-sweeping machines now on the market is the Furnas machine, in which the usual rotary brush is replaced by a suction hood on a pipe leading to a fan mounted on the machine. The general arrangement of the apparatus is shown in the accompanying diagram, Fig. 1, while Fig. 2 is a view of the machine. In Fig. 1 the exhaust fan is shown at A, creating a current from the street surface through the hood B, the pipe C and the dust box D. From this box the air is drawn through the channel E to the fan, and then discharged through the channel F to the hood B. The fan and air passages are so arranged that the air and dirt are carried as rapidly as possible from the street surface to the dust box, and the air is then carried out of the dust box and back to the street surface at as low a velocity as possible. The fan used is a 35-in. Sturtevant mill exhaust fan.

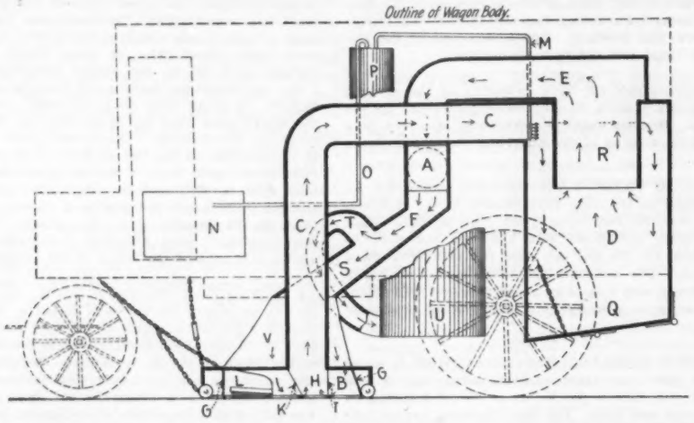

FIG. 1.—DIAGRAM SHOWING ARRANGEMENT OF APPARATUS IN THE FURNAS PNEUMATIC STREET SWEEPING MACHINE.

The outer hood B of the suction apparatus, is about 36 × 78 ins., and has trailing canvas aprons, G G, which are weighted, so as to remain in close contact with the street surface. The air passes from the outer hood, B, to the inner hood, H, principally through the opening under the partition I, which opening is about ⅝ in. high and 10 ft. 5 ins. long. The partition I is made of thin steel plates, which can swing backward to pass obstructions, but cannot swing forward. The partition K of the inner hood is similar to the canvas aprons G of the outer hood, but heavier, in order to resist the increased suction. The dirt is loosened from the surface of the street by the stationary steel brushes L, is passed over by the partition or apron K, and is then picked up by the current of air, drawn through the opening under I with considerable velocity. These hoods and aprons are all held in a wooden framework, which is carried on several pairs of 6-in. wheels, and is drawn by chains attached to the wagon frame or body, as shown in the cut. There is also a similar opening to that under I at each end of the inner hood, H. The inner hood, H, has a cross-section of about 20 sq. ins. at each end, increasing to about 50 sq. ins. at the center, to accommodate the additional air coming in through the opening under I, making the sum of the opening of two sides about 100 sq. ins. The cross-section of I is not more than 70 sq. ins., so that the maximum velocity of current is found where the dirt is to be picked up.

The uptake pipe, C, is at the middle of the wagon, and is 10½ × 8 ins., with an area of 84 sq. ins. It connects with the inner hood H, and enters tangentially the cylindrical dust box D, 44 ins. diameter and 40 ins. high. At the point of entrance a steam jet from pipe M strikes the current at an angle of 45°, the steam escaping from holes in the side of the pipe, as indicated by the short arrow heads. This steam serves to moisten the dust and causes the greater part of it to settle to the bottom of the box. The steam through M comes from the exhaust of the 6-HP. engine at N (which drives the blower), the exhaust passing through the pipe O, its pressure being equalized and made as nearly constant as possible in the cylindrical receiver, P, which is an ordinary plumber's hot water tank of 35 gallons capacity, with suitable pipe connections. The cylindrical dust box D opens into a rectangular box Q, which is 44 × 68 ins. and 22 ins. deep, in which the moistened dust accumulates. When it is desired to empty this box, the bottom is let down by the chain shown, and the load is dumped on the street to be picked up by the team. About 1½ minutes is the time necessary for dumping. The air, relieved of nearly all its load of dust, returns through the cylinder R, 24 ins. diameter, located in the center of the cylindrical dust box D, to the channel E, which has a cross-sectional area of about 300 sq. ins., as the air has now done its work, and it is desirable to remove it from the dust bin with as low a velocity as possible to save power and to save draft from the dust bin.

The exhaust fan, A, draws the air from the channel, E, through a circular intake 13 ins. in diameter, and forces it out through the channel F, which at A is 13 ins. square, and increases to 15 × 17 ins at the bottom of the wagon bed near S. The air in the channel E has come from the dust bin and still has some dust in it, though nearly all has been removed, as hereafter described. To aid in getting the air in the circuit to the street surface with as low a velocity as possible a portion of the air (about 10%) is diverted through the branch T, about 8 ins. diameter. This branch is the feeder for the upright boiler and furnace U, 30 ins. diameter and 66 ins. high, which furnishes the steam needed for the apparatus. Most of the dust remaining in the air coming from D through the fan is thus burned in the furnace and does not escape to the street, while any dust passing on to the hood is again drawn up through B, H and C. Another device for reducing the velocity of the current of air in S is the enlargement of the channel as stated, which enlargement is greatly increased below the wagon bed by means of the canvas-walled passage V from the channel S, 15 × 17 ins., to the outer hood, B, of the suction apparatus. The air extracted through the furnace must be replaced by air drawn under the aprons and the ends of the trailing apparatus. All other parts of the apparatus being airtight, it is evident that no air once in the circuit can leave it except through the furnace, and there is, therefore, no dust distributed about the neighborhood by the machine. The weight of the machine, with coal, water and men ready for work is about 6,500 lbs., which may be increased to 8,500 lbs. by the load in the dust box before dumping.

No machines have been put in use anywhere except in Indianapolis. Five have been built for use in that city, and two more are under construction. About 136 squares of 10,000 sq. ft. each, or 1,360,000 sq. ft., have been swept in twelve hours on each of two successive nights, and on one night 142 squares were swept. This meant about 30 miles of travel. Probably 120 squares is a normal day's work. The force of the machine consists of three horses and two men. In addition, one wagon with two horses and one man is required for hauling away the sweepings, but two wagons can haul away the sweepings from three machines. No men are required for sweeping the gutters, as the hood runs within an inch or so of the curb, and thus covers the entire surface of the street. The city pays for the day work, which is done by men with scrapers removing droppings and a team carrying away the piles made by the men. The present contract with the Indianapolis Street Cleaning Co. covers 17 miles, all of which is cleaned three times a week, and about 1¼ miles of the business streets six times a week. Two machines do this work and 17 men are required for the day work.

The machine cannot clean when the street is wet, but it can get on the street for good work as quickly as brooms can. Brooms will sweep clean while the rain is falling, but for some time after the rain has stopped will simply plaster the mud on the street and remove little or none of it. This also happens if the sprinkling cart ahead of the broom wets the street too much. If the street is too dry the broom raises a heavy cloud of dust, whereas, the pneumatic machines raises no dust.

The wagon body is about 6 ft. 6 ins. wide, 16 ft. long and 7 ft. 6 ins. high from the ground to the top of the body. The two first machines were driven by steam power instead of being hauled by horses, but the horse machines are considered preferable. Anthracite coal is used for fuel, and there is no appreciable escape of smoke or steam visible. The machine is the invention of Mr. R. W. Furnas, of Indianapolis, Ind., to whom, as well as to Mr. C. C. Brown, formerly City Engineer, we are indebted for drawings and information used in this article.

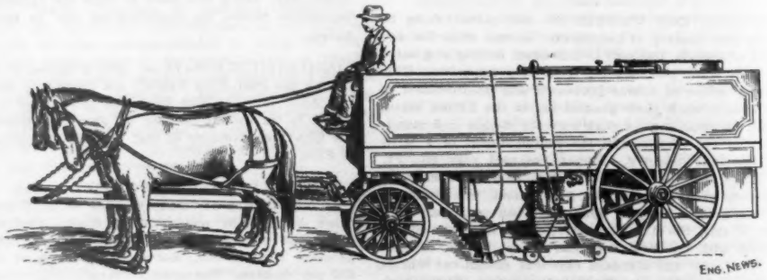

FIG. 2.—VIEW OF FURNAS STREET SWEEPING MACHINE.
R. W. Furnas, Indianapolis, Ind., Inventor.

THE NEW CAPE COD CANAL scheme proposes to utilize the Buzzard's Bay route and not the Bass River route, as stated in our last issue. Mr. E. L. Corthell, M. Am. Soc. C. E., is the principal petitioner for the charter.

ALL SORTS OF FILTRATION PLANS are now being proposed at Philadelphia. An ordinance has been introduced in the common council authorizing the Chief of the Bureau of Water to place domestic filters in every building in the city, and appropriating $500,000 for this purpose. It is said that the ordinance provides that the filters "must be mechanical, not chemical, must be capable of filtering at least twelve gallons each per hour, and must not cost more than $1.50 each." Another plan combines filtration with a revival of the old scheme to lease or sell to the city the right of the Schuylkill Navigation Co., the consideration in this case being $375,000 a year for 50 years; still another plan is a renewal of the attempt to secure an appropriation of $250,000 for putting in a trial filtration plant.

A MODERN FACTORY BUILDING.

A large building has recently been erected as an addition to the manufacturing plant of the Brown & Sharpe Mfg. Co., of Providence, R. I., which embodies many interesting details in construction, and some particulars of these are given below, being taken from a pamphlet issued by the company. The building is a four-story structure, channel-shaped in plan, with the main part 163 × 51 ft., and two wings 73 × 51 and 50 × 43 ft., connecting with an existing building so as to form a hollow square. The first story is 16 ft. 10 ins. high, and the others are 13 ft. 1 in. high in the clear. The total floor area is 50,000 sq. ft.

The foundations, Fig. 1, rest upon piles, arranged to secure a uniform distribution of the load, with not more than 25,000 lbs. per pile. The piles are cut off below the water level, but instead of being capped with timber, they are covered with a bed of cement concrete, 6 ft. wide, brought flush with, and entirely enclosing the heads. The footing stones are 6 × 4 × 1½ ft., dressed to a true bearing on the heads of the piles, and bedded in the cement concrete. On top of this footing, and up to the level of the brick walls, there is a wall of large building stone, 3 ft. 6 ins. thick, about 9 ft. high from the top of the piles. In the center of the building the foundation is built in the same manner to a height of 4 ft., and upon it battered granite piers 12 ft. long are constructed, carrying granite capstones 5 × 3½ × 1½ ft., upon which rest the cast iron column bases.

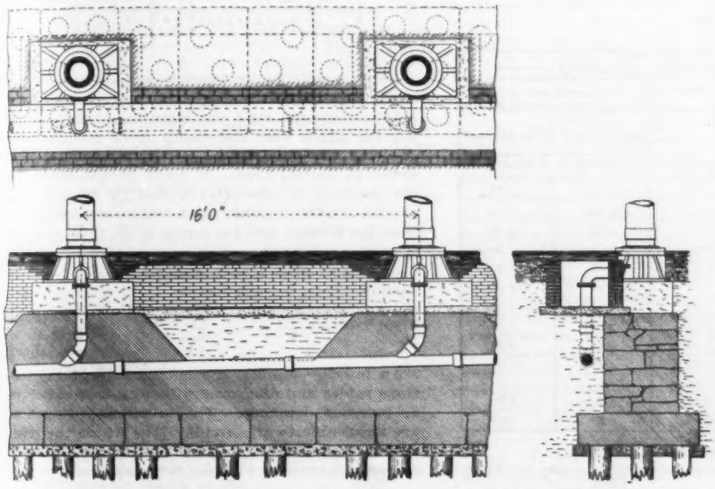

FIG. 1.—FOUNDATIONS AND CENTER COLUMNS OF FACTORY BUILDING.
Brown & Sharpe Mfg. Co., Providence, R. I.

Above the foundation the construction is of the steel frame type. The wall columns are made up of steel Z-bars riveted to a central plate; for the first floor 7-16 × 10 ins., weighing 75 lbs. per ft.; for the second and third stories, 5-16 × 10 ins., 56 lbs. per ft., and for the fourth floor, ¼ × 8 ins., 38 lbs. per ft.

The walls are 24 ins. thick through the pilasters, including the Z-bar columns and ventilating flues. Only a few more bricks are required for this construction than would be necessary for a 12-in. solid wall, while the supporting power is equal to that of a solid 36-in. wall. The walls are also provided with ventilating flues, Fig. 2, two to each pilaster (one on each side of the columns), made of special-shaped fireclay flue lining, and connecting with each room near the floors and ceilings by means of registers. These flues have a sectional area somewhat greater than an 8-in. circular flue, and are specially designed to assist in the proper distribution of the hot air supply, by means of the registers. The tops of the flues are offset to clear the granite coping, and are closed by marble slabs 2 ins. thick, set at a slight angle to drain the water from the coping onto the roof proper, as shown in Fig. 3.

The roof beams are 12-in. I-beams, c. to c., and correspond in position to the floor beams below. They support porous terra-cotta arches, Fig. 4, formed of special-shaped tiles to make the top surface flat and the under surface arched. The floors are carried by 4-in. brick arches, as shown in Fig. 2. The roof arches are covered with a coating of cement about 1 in. thick, and on top of this is laid 5-ply tar and gravel roofing. The corners between the walls and roof are filled to a height of 6 ins. with cement, beveled at an angle of about 45°, and covered with a copper flashing, this in turn running up under the cap flashing on the vertical face of the walls, as shown in Figs. 3 and 4. The face of the wall above the flashing is then covered with a coat of asphaltum and pitch, to prevent the possibility of any moisture accumulating.

The ground floor rests upon a 12-in. bed of cement concrete. The concrete was mechanically mixed, and consists of 1 part Portland cement, 4 to 4½ parts sharp sand, and 8 parts crushed stone. This was put down as dry and stiff as possible, forming a continuous foundation, which is sufficiently strong for any of the machines, and will thus enable the location of any machine to be changed without requiring the building of new foundations, or the sacrifice of old ones. Over this cement concrete is a coating of pitch, applied hot, and above this is a ½-in. coat of tar concrete, so that no moisture can find its way up into the floor planks. In this foundation are bedded chestnut sleepers, to which are spiked the floor planks. The floor proper consists of 2¾-in. spruce planking, tongued and grooved, over this a diagonal course of 1⅛-in. matched spruce, and over all is laid 1⅛-in. hard pine, jointed square for convevience in making repairs.

The roof and floor beams are supported at the outer ends upon the steel Z-bar columns enclosed within the pilasters, to which they are framed so as to support the framework entirely independent of the brick wall. At the center of the building the floor beams of each floor are framed to a double line of 20-in. I-beams, which rest upon a single row of cast-iron columns placed 16 ft. c. to c. These columns are 16 ins. diameter at the bottom, tapered to 14 ins. at the top, for the first floor, and of correspondingly suitable proportions for the other floors. A double row of 15-in. beams carries the 12-in. roof beams. The second floor beams weigh 60 lbs. per ft.; those of the third and fourth floors 41 lbs. per ft., and the floors are thus capable of safely carrying, in addition to their own weight, a uniformly distributed load of 375 lbs. per sq. ft. for the second floor, and 225 lbs. per sq. ft. for the third and fourth floors. Over these beams and brick arches is laid the heavy 5-in. spruce and hard pine flooring, as described for the ground floor.

The hollow square plan of the building, and the proportion of width to height of stories, together with windows 50 ins. wide, 8 ft. between centers, and extending practically the entire height of each floor, from the work benches to the ceiling, insure an ample supply of light. Ventilation is provided for by the wall flues above described.

The water is conducted from the roof through the cast-iron columns which support the floor and roof beams at the center of the building, the roof beams sloping toward these at about ⅛ in. per ft. The columns are coated inside with tar to prevent rusting, and after passing down through these the water is carried off through the cast-iron column bases, by special outlets connected with the drain, as shown in Fig. 1.

A convenient arrangement for running pipes, wires, etc., is obtained by having a drain conduit, or pipe trench, near the center of the building. This runs parallel with the main column foundations (these forming a part of one side), and varies from 2 to 3 ft. in depth. The covering consists of removable sections of flooring of the same thickness as the regular flooring.

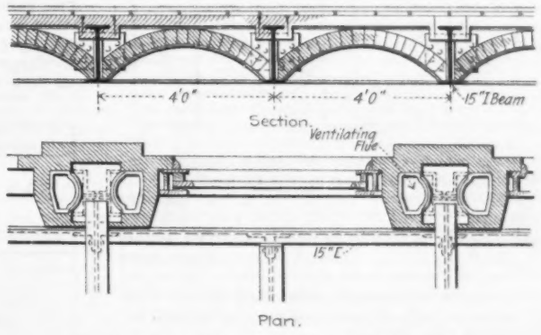

Fig. 2.—Plan and Section of Floor and Wall System.

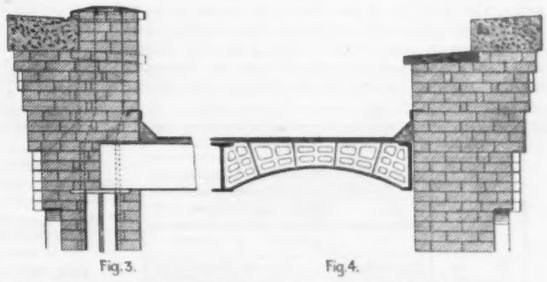

Fig. 3.—Roof and Top of Wall Flues. Fig. 4.—Roof Construction.

In accordance with the company's practice, the building was designed and planned by its own engineers, and it was originally intended to have the erection done by day work, but in view of the pressure of business at the time it was commenced, the contract for construction was given to Norcross Bros., of Worcester, Mass.

EIGHT PERUVIAN METEOROLOGICAL STATIONS are maintained by the Harvard College Observatory. The principal one is at Arequipa, 8,050 ft. above the sea and 80 miles from the coast. At Mollendo, on the coast, is another 85 ft. above sea-level; between Mollendo and Arequipa is another station, La Joya, placed in the center of a rainless, barren district, and 4,140 ft. above the sea. The most interesting station is on the summit of the volcano, El Misti, 19,200 ft. above sea-level and about 10 miles northeast of Arequipa. This is now the highest meteorological station in the world; it is equipped with a meteorograph, devised by Mr. S. P. Fergusson, of the Blue Hill Observatory, Mass., which automatically records temperature, pressure, humidity and wind direction and velocity and only requires rewinding once in three months. This obviates the frequent visits from Arequipa once necessary. The other stations are on the flank of El Misti, 15,700 ft.; at Alto de los Huesos, 13,400 ft.; Cuzco, between the Eastern and Western Andes, 16,100 ft., and at Santa Ana, east of the Andes, and 3,400 ft. above sea-level.

TABLES AND DIAGRAMS FOR FACILITATING THE COMPUTATION OF ESTIMATES FOR SEWERAGE WORK*

By S. M. Swaab, Civil Engineer, Philadelphia, Pa.
(With inset.)

The object of the accompanying tables and diagrams, as the title suggests, is to facilitate the computation of estimates for sewerage work. The figures represent in the case of masonry the gross amount of brick and mortar and stone and

Circular Sewers

Size	Brick Masonry 9 inch Arch, Haunch and 9 inch counterarch	Rubble Masonry Full Cradle 9 inches thick under Centre and Counterarch	Rubble Masonry Partial Cradle 9 inches thick under Centre and Counterarch	Brick Masonry 4½ inch Brick ring all around	Brick Masonry 9 inch Brick ring all around
Ft. In.	Quantity in cubic yards pr. linear foot				
2 0	0.227	0.3		0.103	0.24
3	.235	.33		.114	.261
6	.244	.35		.125	.268
9	.270	.43		.136	.3
3 0	.292	.46		.147	.327
3	.320	.54		.158	.35
6	.348	.59		.169	.37
9	.360	.65		.18	.39
4 0	.38	.7		.19	.41
3	.40	.74		.20	.436
6	.42	.78		.21	.458
9	.45	.86		.223	.48
5 0	.49	.90	0.74	0.234	0.50
3	.54	0.96	0.80		
6	.57	1.03	0.87		
9	0.60	1.07	0.93		

mortar which comprise the brick masonry and stone masonry indicated by the tables.

The quantity of mortar in brick masonry amounts to about 25 to 30% of the total bulk, and the quantity of mortar in stone masonry amounts to about 32 to 35%. Five hundred bricks, more or less, of standard size are required to lay a cubic yard of brick masonry where the joints are from ¼ to ⅜ in. thick. About 2% should be allowed for breakage and cutting.

The quantities of excavation indicated by the diagrams are the minimum quantities which will allow the bottom of the trench to be as wide as the greatest external width of the "cradle" and to continue of that width to the top. The quantities of excavation for sewers not in "masonry cradle" refer to a trench equal in width at the

Circular Sewers

Size	Brick Masonry 13 in Arch, Haunch and 9 inch counterarch	Rubble Masonry In Full Cradle 12 inches thick under counterarch at centre	Rubble Masonry In Partial Cradle 12 inches thick under counterarch at centre
Ft. In.	Quantity in cubic yards pr linear foot		
6 0	0.885	1.33	1.0
3	0.9	1.40	1.06
6	0.927	1.48	1.1
9	0.975	1.53	1.16
7 0	1.0	1.57	1.2
3	1.04	1.60	1.29
6	1.06	1.68	1.33
9	1.1	1.78	1.375
8 0	1.14	1.84	1.414
3	1175	1.93	1.47
6	1.21	2.0	1.52
9	1.25	2.1	1.58
9 0	1.28	2.2	1.63
3	1.32	2.27	1.7
6	1.35	2.35	1.77
9	1.39	2.43	1.84
10 0	1.43	2.51	1.90
3	1.46	2.63	2.0
6	1.50	2.72	2.10
9	1.53	2.86	2.20
11 0	1.57	3.0	2.33
3	1.60	3.1	2.40
6	1.63	3.2	2.50
9	1.675	3.35	2.60
12 0	1.70	3.45	2.66

top to the greatest external width of the sewer, and at the bottom to conform to the shape of the section.

Allowance has been made in all the diagrams so that the quantities indicated thereon represent the total amount of excavation to the "outside bottom" of the sewer; but as the figures representing the depth of the sewer below grade are invariably given on the "inside bottom" of the sewer, the depth, in these diagrams, for convenience, is also given to the "inside bottom."

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Method of Using the Diagrams.

The internal dimensions in feet and inches of the egg shape and circular sewers will be found on the left of the diagrams in every case. Run over this line toward the right until the curve is found representing the depth to the inside bottom of the sewer below the surface; then follow down the vertical line which intersects the curve at this point to the bottom of the diagram, on which may be read off at once the quantity of excavation.

All the quantities given in the tables and diagrams are in cubic yards and decimals of a cubic yard per linear foot of sewer. The quantities given in the tables have merely to be multiplied by the length of the sewer to find the total amount of brick or stone masonry, excavation, etc., in any given piece of work.

The following examples will illustrate the method of using the tables and diagrams:

Example 1.—Given a 3-ft. diameter circular sewer in "full cradle," 1,000 ft. long, 12 ft. deep to inside bottom:
From Table No. 1.:

Circular Sewers

Size	Brick Masonry 18 in Arch, Haunch and 9 inch counterarch	Rubble Masonry 12 inches thick under counterarch at centre In Full Cradle	In Partial Cradle
Ft. In.	Quantity in cubic yards pr. linear foot		
12 0	1.75	3.45	2.66
3	1.82	3.50	2.72
6	1.9	3.58	2.76
9	2.0	3.70	2.84
13 0	2.1	3.75	2.91
3	2.12	3.85	2.97
6	2.25	3.90	3.06
9	2.31	3.95	3.14
14 0	2.40	4.22	3.23
3	2.50	4.4	3.36
6	2.60	4.6	3.5
9	2.65	4.75	3.70
15 0	2.75	5.03	3.90

Quantity of brickwork = —0.292 / 1,000 cu. yds. per lin. ft.
Total " " 292 cu. yds. per 1,000 ft.
From Table No. 1:
Quantity of masonry = —0.48 / 1,000 cu. yds. per lin. ft.
Total " " 480 cu. yds. per 1,000 ft.
From Table No. 8:
Quantity of excavation = —3.54 / 1,000 cu. yds. per lin. ft.
Total " " 3,540 cu. yds. per 1,000 ft.

Example 2.—Given an 8-ft. diameter circular sewer in "partial cradle" 1,000 ft. long, 18 ft. deep to inside bottom:
From Table No. 2:
Quantity of brickwork = —1.14 / 1,000 cu. yds. per lin. ft.
Total " " 1,140 cu. yds. per 1,000 ft.
From Table No. 2:
Quantity of masonry = —1.414 / 1,000 cu. yds. per lin. ft.
Total " " 1,414 cu. yds. per 1,000 ft.
From Diagram No. 13:
Quantity of excavation = —9.4 / 1,000 cu. yds. per lin. ft.
Total " " 9,400 cu. yds. per 1,000 ft.

Example 3.—Given a 2-ft. 2-in. × 3-ft. 3-in. egg-shape sewer in "full cradle," 1,000 ft. long, 10 ft. deep to inside bottom.
From Table No. 5:
Quantity of brickwork = —0.25 / 1,000 cu. yds. per lin. ft.
Total " " 250 cu. yds. per 1,000 ft.
From Table No. 5:
Quantity of masonry = —0.50 / 1,000 cu. yds. per lin. ft.
Total " " 500 cu. yds. per 1,000 ft.
From Diagram No. 17:
Quantity of excavation = —2.58 / 1,000 cu. yds. per lin. ft.
Total " " 2,580 cu. yds. per 1,000 ft.

Example 4.—Given a 4-ft. 6-in. diameter circular sewer, 9-in. brickwork (double ring of brick all around) 1,000 ft. long, 9 ft. 6 ins. deep to inside bottom.
From Table No. 1:
Quantity of brickwork = —0.458 / 1,000 cu. yds. per lin. ft.
Total " " 458 cu. yds. per 1,000 ft.
From Diagram No. 7:
Quantity of excavation = —2.15 / 1,000 cu. yds. per lin. ft.
Total " " 2,150 cu. yds. per 1,000 ft.

Table showing Quantity of Excavation in cubic yds. pr. linear foot of Circular Sewer in Full Cradle

Diameter Ft.-In.	Depth to inside bottom of sewer, in feet 10'	11'	12	13	14	15	16
2 0	2.3	2.53	2.71	2.92	3.13	3.36	3.58
2 3	2.49	2.65	2.76	3.13	3.27	3.4	3.72
2 6	2.56	2.78	3.01	3.23	3.4	3.71	3.94
2 9	2.6	3.06	3.25	3.3	3.75	4.0	4.25
3 0	3.0	3.26	3.44	3.6	3.87	4.16	4.61
3 3	3.17	3.3	3.75	4.12	4.38	4.62	4.9
3 6	3.45	3.78	4.0	4.27	4.9	4.97	5.3
3 9	3.6	3.9	4.25	4.4	4.9	5.2	5.52
4 0	3.70	4.12	4.46	4.8	5.13	5.47	5.81
4 3	3.85	4.18	4.50	4.85	5.2	5.53	5.9
4 6	3.89	4.24	4.59	4.9	5.3	5.67	6.0
4 9	3.96	4.32	4.68	5.0	5.4	5.76	6.11

Quantity in cubic yards

For quantity of excavation in rock, where the arch, haunch and counterarch are used without masonry cradle, read the quantity of excavation for the given size and depth from the diagram showing the quantity of excavation for circular sewer in partial cradle in cubic yards; next find the quantity of masonry required for the sewer in partial cradle in cubic yards; subtract the latter from the former, and the result is the total amount of rock excavation.

Example 5.—Given a 10-ft. diameter sewer in "rock excavation" 17 ft. to inside bottom.
From Diagram No. 14.....10.7 cu. yds. excav. per lin ft.
From Table No. III..... 1.9 " " masonry.
8.8 " " rock excavation.

An infinite number of combinations of the various tables and diagrams will suggest themselves as occasion demands. The tables and diagrams are applicable to all combinations where the general "dimensions and design" of the sewer sections compare favorably with the dimensions of the sec-

Egg Shape Sewers (French Section)

Size	Brick Masonry 9 in Arch, Haunch & 4½ in. counterarch	Rubble Masonry 9 in. thick under counterarch at centre	Brick Masonry single ring all around	Brick Masonry double ring all around
			4½ in. thick	9 in thick.
	Quantity in cubic yards pr. linear foot			
1'6" x 2'3"	0.2	0.35	0.099	0.231
1'8" 2'6"	0.214	0.37	0.108	0.249
1'10" 2'9"	0.228	0.42	0.117	0.267
2'0" 3'0"	0.237	0.44	0.126	0.286
2'2" 3'3"	0.25	0.50	0.136	0.304
2'4" 3'6"	0.266	0.56	0.144	0.321
2'6" 3'9"	0.28	0.49	0.153	0.34
2'8" 4'0"	0.296	0.63	0.163	0.359
2'10" 4'3"	0.31	0.71	0.172	0.376
3'0" 4'6"	0.32	0.81	0.181	0.39
3'2" 4'9"	0.335	0.875	0.190	0.41
3'4" x 5'0"	0.352	0.981	0.20	0.432

tions on which these tables were based, as shown by the headings of the different tables.

THE ELEVATION OF THE FOUR TRACKS of the Providence Division of the New York, New Haven & Hartford R. R., at Boston, Mass., is progressing. A heavy temporary trestle has been built by Mairs & Lewis, of New York, granite retaining walls will be erected along each side of the present right of way, and an earth bank will be filled in between them, upon which will be the ordinary track construction. The steel bridges over the streets will be built by the Berlin Iron Bridge Co., the Pennsylvania Steel Co. and the Boston Bridge Works. They will have solid floors of the type shown in our issue of July 26 and Nov. 15, 1894, invented by Mr. Geo. B. Francis and Mr. E. P. Dawley.

COMMERCIAL VALUE OF ACETYLENE GAS AS AN ILLUMINANT.*

By T. A. Ferguson.

Acetylene is produced from calcium carbide merely by the application of water, the action being shown by the equation:

$$Ca\,C_2+2H_2O=Ca\,O\,H_2O+C_2H_2$$

When the carbide is thus brought in contact with the water, the acetylene gas is driven off rapidly and its presence is distinguished by its very pungent odor, somewhat resembling phosphorus. When lighted, it burns with a deep yellow flame and is extremely sooty, but when generated at an even pressure, and burned with proper burners designed for the use of acetylene, it gives a beautiful white light.

The results of tests made at Spray, N. C., by the writer, show that 8.3 lbs. of carbide is produced by each electrical HP. in one day, or .463 lbs. per K-W. hour; also that the efficiency of production was 58.4%. Experience at Spray shows that the carbons used as electrodes last about 70 hours, with the same amount of energy as used in this test. The cost of these carbons is $2 each, which approximates 6 cts. per lb., or 18 cents per K-W. hour. The cost of lime I have put at $5 per ton and coke at $2.50 per ton. The question of the cost of electrical energy is the all important one, so that I have taken the Niagara price of $20 per electrical HP. per year of 8,760 hours.

The estimate is further based on the assumption that the carbide plant is to be operated at full load 24 hours per day and 365 days each year, so that the actual cost per electrical HP. hour of energy consumed may not exceed $20 divided by 8,760, which is 0.238 cts., or 0.317 cts. per K-W. hour. With this data as a basis, the cost of producing one ton of calcium carbide at Niagara Falls, in a plant having ten 200 K-W. furnaces, producing ten tons of carbide per day, would be as follows:

		Cost per ton.
Power.		
4,320 K-W. hours at .317 cts. per K-W. hour.		$13.69
Materials.		
2,085 lbs. of lime at $5 per ton		5.21
1,339 lbs. of coke at $2.50 per ton		1.67
Carbons.		
Carbons for 4,320 K-W. hours at 18 cts. per K-W. hour		7.78
Supervision and labor operating two shifts 12 hours each:		
1 superintendent at $5	$5	
1 chemist at $4	4	
2 foremen at $2.50	5	
10 regulating men at $1	10	
6 furnacemen at $1.50	9	
2 grinders at $1.50	3	
6 laborers handling, grinding and mixing at $1.50	9	
	$45	
Labor per ton 45 ÷ 10		$4.50
Cost of barrels and preparing carbide for shipment		1.00
		$33.85
Interest at 6% on $25,000, the investment necessary to erect the factory, furnaces, crushing and mixing machinery, apparatus for handling and regulating	$1,500	
Depreciation on $25,000 at 5%	1,250	
Taxes at $10 per $1,000	250	
Insurance at $3 per $1,000	75	
	$3,075	.84
Cost of production at Niagara		$34.69
Freight from Niagara to New York, Philadelphia, Boston or Chicago at 15 cts. per 100 lbs.		3.00
		$37.69

This cost per ton of calcium carbide is intended to represent the cost of manufacture to a large gas company operating in New York, Boston, Philadelphia or Chicago, with its calcium carbide works at Niagara, and whose business would be to produce acetylene from the carbide in the city where the gas is to be used and to distribute it to its customers through its existing mains. It is not intended to represent the cost cleared off its books of any corporation or firm whose sole business would be to manufacture calcium carbide for the market, for to cover that case we must add to the above estimate the cost of general expense, including administration, royalties and selling expenses, which, of necessity, would be equal to a large percentage of the factory cost as given. In many articles and circulars treating of this question, it has been customary to place the actual cost of acetylene as produced from the carbide, taking the factory cost of the carbide as the basis, against the selling price of illuminating gas at $1.00 per 1,000 cu. ft. This, of course, is not a fair comparison and is very misleading.

The results of the tests at Spray show that for each pound of carbide there was obtained 5.24 cu. ft. of acetylene, or 10,500 cu. ft. per ton; therefore, the cost per 1,000 cu. ft. of acetylene would be one-tenth the cost of one ton of calcium carbide. The candle power of acetylene being placed at 240 for each 5 cu. ft. of gas and the c. p. of water gas in the large cities at 25 for each 5 cu. ft. of gas, it will be seen that the c. p. of acetylene is ten times that of water gas per 1,000 cu. ft., and, therefore, the cost of acetylene giving the same c. p. as water gas would be equivalent to water gas at a cost per 1,000 cu. ft. equal to 1-100 of the cost per ton of calcium carbide. For example, if calcium carbide costs the company $100 per ton, then the cost of acetylene gas in the holder will be equivalent to 25 c. p., water gas costing $1.00 per 1,000 cu. ft. in the holder.

The present average cost of illuminating gas in the holders of the large gas companies approximates 30 cts. per 1,000 cu. ft., while the cost of acetylene gas in the holder with calcium carbide at $37.69 per ton would be equivalent, light for light, to illuminating gas at 37.7 cts. per 1,000 cu. ft., making the cost per c. p. hour of pure acetylene approximately 20% higher than that of ordinary illuminating gas. If acetylene were mixed with air and distributed, the cost would be less. This has been done in an experimental way, using 60% acetylene, and 40% air, but the advisability of attempting to distribute such a mixture through a system of mains in a city for commercial use is exceedingly questionable, owing to the risk of the mixing being improperly done and the quantity of acetylene falling to such a percentage as to form an explosive mixture.

It has been suggested that the cost of distribution, as well as the cost of mains and maintenance, which constitute a large portion of the cost in the lighting industry, might be saved by the use of liquid acetylene, put up in cylinders and delivered to the stores, residences and offices, so that the consumer might generate his own gas as required. It appears to the writer that this method is an entirely impracticable and uncommercial one, as there are almost insurmountable objections to be overcome. Neither the average business man nor the occupants of a residence wish to be bothered with the care necessarily attendant upon the use of the cylinders of acetylene. It would be necessary either to have two cylinders ready for service, or to have a second one placed in service before the first one was exhausted, and in all probability the busy man would find himself in darkness at the time when he most needed the light, owing to the fact that he had neglected to renew his cylinder. The pressure of the gas in these cylinders is from 600 to 700 lbs., so that it is necessary to use a reducing valve which will give a pressure of 1 oz. The same valve that is used with the Pintsch system of railway lighting is employed, but this, in all probability, would not be kept in condition by the ordinary householder or storekeeper, and the consequence would be that the full pressure might be imposed upon the pipes, and in case this were prevented by the use of an auxiliary safety valve, then, every failure of the reducing valve would allow all the gas to escape and be lost. The use of acetylene cylinders would increase the danger in case of fire, since the gas would escape from the cylinders, and explosions of the mixture of acetylene gas and air would possibly follow. Liquid acetylene should find a field in the lighting of country estates, railway trains, and for use in carriages, bicycle and locomotive head lamps, and in isolated places where distribution by mains is not possible.

When acetylene was first brought forward to be used commercially, it was expected that the gas companies might still maintain their existing gas works and use acetylene to enrich their gas and furnish a 25 c. p. flame as formerly, but at a much less cost. Experiments have shown, however, that although coal gas may be enriched by acetylene, water gas is not susceptible to enrichment through it. Water gas, which is furnished in nearly all the large cities, has little illuminating power of its own, is now treated with petroleum, and it is only when enriched to a certain c. p. that acetylene may be mixed with it without loss in c. p., so that we cannot, as at first supposed, substitute acetylene for petroleum, and use it economically as an enricher of low c. p. water gas.

It has been suggested that the manufacture of calcium carbide might be carried on by the central station electric lighting companies as a by-product, furnishing the energy necessary for its production during the hours of light load upon the lighting system, thus bringing the load curve of the station nearer to a straight line and thereby improving the economy of the station operation. It will be seen from the figures given in the estimate of the cost of producing the carbide, that the cost of power is a very important factor, and if we increase the cost given, of $20 per HP. per year, we shall correspondingly increase the cost of the carbide. From experience of the cost of operation of the largest central lighting stations in this country, the writer can safely state that the absolute cost of fuel alone in the most economically-operated lighting station of the most modern type of multiple expansion condensing plant averages 0.3 ct. per K-W. hour, or approximately $20 per HP. per year continuous service, while the total cost of power generation in the station would average over double that amount. In the average of the large central stations the generating cost at the switchboard, without distribution and general expenses, approximate 1 ct. per K-W. hour, which is about $65 per HP. per year, and in smaller stations using steam, double that amount. It is obvious, then, that we may not hope to use our present central stations during the minimum hours for the manufacture of calcium carbide as a by-product, while the cost of power in our stations remains as it is at present; and the amount of power required for the production of carbide so excessive, as the cost of its production by the central station would be prohibitive. It would be much better and more profitable for the central station manager to sell his electrical energy through the incandescent or arc lamp at the same price per K-W. hour than to use the energy for the production of carbide, since the cost per c. p. hour would be less when the electrical energy is converted into light directly through the incandescent and arc lamps than through calcium carbide and pure acetylene, assuming the cost of distribution and general expense to be the same in each case. Take, for example, carbide at $40 per ton, which means 40 cts. per 5,000 c. p. hours of acetylene gas in the holder, or 125 c. p. hours for 1 ct. Compare this with electrical energy at the switchboard at 2 cts. per K-W. hour. For each K-W. hour generated, we obtain 20 50-watt incandescent lamps, each giving 16 c. p., making a total of 320 c. p. hours per K-W. hour, or 160 c. p. hours for 1 ct., which is 28% more c. p. for the same expenditure of money by the use of the incandescent lamp directly as a converter of electrical energy into light as compared with the conversion by means of carbide of calcium and acetylene.

If we take the case of the arc lamp and add to the cost of the electrical energy 1.5 cts. per K-W. hour for the carbons, trimming and repairs, making the total cost 3.5 cts. per K-W. hour, we find it still more advantageous. Assuming that a 500-watt arc lamp gives 1,000 c. p., we have 2,000 c. p. hours per K-W. hour, or 575 c. p. hours for 1 ct., which is 4.6 times the illumination for the same money as compared with pure acetylene gas.

Taking the cost per K-W. hour at the switchboard in the large central stations, we obtain 320 c. p. hours for 1 ct., which is 156% more c. p. for the same expenditure of money by the use of the incandescent lamp directly as a converter of electrical energy into light as compared with the conversion by means of carbide of calcium and acetylene.

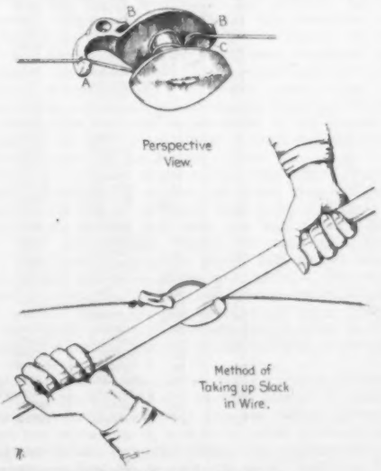
By means of the arc lamp on the basis of cost of 1 ct. per K-W. hour for electrical energy and 1.5 cts. per K-W. hour for carbons, trimming and lamp repairs, we obtain 800 c. p. for 1 ct., or 6.4 times the illumination for the same money as compared with pure acetylene gas.

From these deductions and considerations, it may be concluded, in the light of our present knowledge, that acetylene gas should not drive the incandescent and arc lamp from the lighting field, neither should it make such inroads on the electric lighting business as to materially affect the earnings of existing central station companies.

*Extract from a paper read before the National Electric Light Association, New York, May 7, 1896.

A TIGHTENER FOR WIRE FENCES.

Where wire fences are used there is often need of a device for promptly and effectively taking up the slack of loose wires, and the accompanying cut represents a handy wire tightener now being put on the market. It is claimed to possess advantages over tighteners applied at the end posts in that it is put on at the middle of the panel and pulls the wire in both directions. It is an iron casting, made without coring (so that the cost of manufacture is small), and has two oval webs about 2 × 2½ ins., 1 in. apart, one of the webs



A Wire Tightener for Fences.

having a lug, A, which is hooked over the wire when it has been drawn tight, thus preventing the wire from uncoiling. The wire is coiled around the central stem by turning the tightener by means of a flat bar inserted between lugs B B on the outer side, as shown. Only half a turn is required to get a grip on the wire, as the inner lug C at once catches the wire. A small hole in one of the lugs allows of stringing the tighteners together for shipment, thus saving the cost of packing and boxing. This device is manufactured by the Standard Wire Fence Co., of Canandaigua, N. Y.

COMPARISON OF ECONOMY OF VARIOUS CENTRAL STATION LIGHTING PLANTS.*

The committee presents a tabulated statement of watt hours produced per pound of coal from 82 central stations using coal as fuel, and from one using crude oil, and is able to show the class of equipment from all, boiler tests from 32, and engine efficiency from eight. So far the work has been carried forward on the lines of the previous reports by this committee. In addition to this, we have been able, from the information furnished, having an output of one to ten million watt hours per day. Four of the large stations represent a production of 94,270 K-W. hours and a consumption of 524,667 lbs. of coal or 179 watt hours per pound of coal. The aggregate output of these 49 large stations reaches the production of 212,617 K-W. hours in one day at an expense of 1,316,703 lbs. of coal, or an average of 161 watts per pound of coal. The aggregate output of 32 smaller stations, those producing less than 1,000,000 watt hours per day, represents a production of 11,973 K-W. hours with an expenditure of 194,274 lbs. of coal, or 62 watts per pound of coal. The aggregate electrical output of entire report, several stations having reported for a long period, in one case (report 6) for one year, represents the generation of 4,618,976 K-W. hours at an expense of 28,274,536 lbs. of coal, or an average of 164 watt hours per pound of coal. The average efficiency of the 81 reports using coal as fuel is 108 watt hours per pound of coal; one report giving the production from crude oil shows 1,717 watt hours per gallon of oil.

The load lines shown in the charts have been constructed from 30 min. readings from meters or estimated from voltage and amperes. The committee realizes that in the case of alternating currents the product of amperes times volts may not give the absolute watts, but this method has been considered sufficiently accurate for this work, and has been used in a few instances. The minor points called for in the information blank sent out by the committee relative to evaporation per pound of coal, water used in the engines, calorimeter tests, etc., have not received very general attention, although simple directions were given for this work. The 31 stations reporting the water evaporated per pound of coal show a wide range of boiler efficiency not to be accounted for by the difference in quality of fuel. Report 81 shows 10.5 lbs. of water evaporated per pound of semi-bituminous coal, comparing favorably with report 8, each using horizontal tubular boilers; while report 67 shows only 4.66 lbs. of water evaporated per pound of bituminous coal with the same style of boilers. The average evaporation per pound of coal from all stations giving reports being 7.00. In engine efficiency eight stations report the water con-

TABULATED REPORT FROM ELECTRIC LIGHT STATIONS; SHOWING WATTS PER POUND OF FUEL, EQUIPMENT, EFFICIENCY, ETC.

No. of Report.	Hours in Run.	Watt Hours, One Day.	Coal Used, One Day. Lbs.	Watt Hours Per Lb. Coal.	Fuel—Kind and Grade.	Equipment. (See Foot Notes.) Engines.	Boilers.	Dynamos	Boiler Test. Evaporation. Per lb. Coal.	Per lb. Combustible. Actual.	From and at 212°	Engine Test. Water per hour per I.H.P.	No. of Report.
1	24	3207392	11600	237	Bit. Lump.	D	C	V	6.2	6.87	7.12	—	1
2	24	2397712	11251	213	Bit. Lump. [Screenings.	D	C	V	5.7	6.45	6.69	—	2
3[1]	24	26402256	124383	212	½ Ea. Soft Coal and Hard	A	A	A	7.38	8.81	10.22	18.	3[1]
4[1]	24	5053166	28050	180	½ Anth. ½ Pea and Dust.	B	1A, 5C	B	8.91	—	—	36.9	4[1]
5[2]	24	1818780	10200	178	.4 Coke .6 Coal.	CD	C	V	5.4	5.75	6.41	27.6	5[2]
6	24	11488500	65884	174[4]	Bit. Run of mine.	BDz	C	V	—	—	—	—	6
7	24	1212000	7105	171	" " "	B	C	V	—	—	—	—	7
8	24	825000	5022	164	Bit. and Hard Screenings.	Ex	C	V	10.35	11.48	—	—	8
9	24	4270077	26900	161	½ Anth. ½ Dust and Pea.	B	1A, 5C	V	9.17	—	—	42.2	9
10	14	1718000	11400	151	Bit. Va.	BC	C	V	—	—	—	—	10
11[3]	15½	8030	5500	151	" "	CD	A	Alt.	—	—	—	—	11[3]
12	24	2156000	14403	149	Buckwheat.	3C, 1E	C	Alt.	8.99	10.34	11.23	—	12
13	14	1625000	11440	142	Bit.	BC	C	V	—	—	—	—	13
14	16½	711720	5100	140	Bit. Slack.	D	C	V	—	—	—	—	14
15	16½	727720	5200	140	Bit.	D	C	V	—	—	—	—	15
16	14	1624000	11840	137	Bit. Run of mine.	BC	C	V	—	—	—	—	16
17[2]	14	2734976	19900	137	Slack.	Dx	B	V	8.25	8.9	9.43	—	17[2]
18	14	2589705	19050	136	Slack.	Dx	B	V	7.92	9.35	9.9	—	18
19	14	1520000	11200	136	Bit. Run of mine.	BC	C	V	—	—	—	—	19
20	14	1500000	11000	134	" " "	BC	C	V	—	—	—	—	20
21	14	2722463	20050	134	Slack.	Dx	B	V	7.8	8.8	9.39	—	21
22[1]	24	16149010	121400	133	Slack and Bit.	B	C	V	—	—	—	—	22[1]
23	16	1528100	11505	131	Bit. Lump.	D	C	V	—	—	—	—	23
24	15½	695720	5300	131	Bit.	D	C	V	—	—	—	—	24
25	16	1549100	11860	131	Bit. Run of mine.	B	C	V	7.7	8.3	—	—	25
26[1]	24	5401900	41924	129	Semi-Bit.	EDx	BC	..	9.5	12.2	—	30	26[1]
27	14	1389000	11200	126	Bit.	BC	C	V	—	—	—	—	27
28	16	1568000	12000	131	Bit. Lump.	B	C	V	7.7	8.3	—	—	28
29	13	2103900	16800	125	Anth. Buckwheat.	Cx	C	C	6.84	8.26	8.73	26	29
30[2]	24	2683008	21571	124	Bit. Nut and Slack.	Ex	AC	Bl.P.	—	—	—	—	30[2]
31[2]	17½	3396619	27414	124	.....	—	—	—	9.8	9.8	—	—	31[2]
32[2]	24	1763795	15625	113	½ Ea. Bit. and Anth.	EDx	C	B	8.93	10.57	11.02	—	32[2]
33[1]	24	6794304	62504	109	⅜ Anth. 4 Bit.	Ex	6C, 5A	BE	—	—	—	—	33[1]
34[2]	24	1193876	10475	106	Anth. Buckwheat.	4C, 1E	C	C	—	—	—	—	34[2]
35	24	1074436	10250	105	" "	4C, 1E	C	C	—	—	—	—	35
36	—	100049988[6]	1533000	104	Bit. Screenings.	BC	AB	—	—	—	—	—	36
37[2]	12½	2202363	23080	100	Lignite, Run of mine.	BDx	AC	Alt.	4.8	5.2	—	—	37[2]
38	—	288440	3041	95	Bit. " "	Ex	C	C	—	—	—	—	38
39[2]	9½	454058	4831	94	Slack.	D	A	V	—	—	—	—	39[2]
40[2]	13	903720	9812	92	Bellwood Bit.	BDx	A	—	5.1	5.6	5.93	—	40[2]
41	—	268800	2896	92	" "	Ex	C	C	—	—	—	—	41
42[1]	24	1444831	20800	69	Slack.	Ex	BC	BC	6.33	—	—	—	42[1]
43	6½	93541	1365	68	Buckwheat, Anth.	E	C	C	—	—	—	—	43
44	8	230187	3000	64	.....	Ex	C	B	—	—	—	—	44
45	14¾	310828	5000	62	Bit.	Ex	C	V	—	—	—	—	45
46[3]	15	254745	4520	56	Bit.	Dx	C	C	—	—	—	—	46[3]
47[2]	7½	186412	3810	49	Slack.	Ex	C	B	—	—	—	—	47[2]
48	24	66285375[5]	1160000	57	Bit.	1D, 2Ex	A	C	—	—	—	—	48
49[3]	14	156800	2800	56	Bit. Run of mine.	Ex	C	C	—	—	—	—	49[3]
50[3]	7½	214485	3800	56	Bit.	Ex	C	B	—	—	—	—	50[3]
51	7½	204435	3600	57	Bit.	Ex	C	B	—	—	—	—	51
52[2]	10	6453491[5]	116000	56	Bit. and Slack.	Cx	C	Alt.	—	—	—	—	52[2]
53	7½	217228	4000	54	Bit.	Ex	C	B	—	—	—	—	53
54	7	221250	4200	53	"	Ex	C	B	—	—	—	—	54
55	7½	186412	3810	49	Slack.	Ex	C	B	—	—	—	—	55
56	7	208535	3900	53	Bit.	Ex	C	B	—	—	—	—	56
57	6	161458	3150	51	Bit.	Ex	C	B	—	—	—	—	57
58	7½	174928	3720	47	Bit.	Ex	C	B	—	—	—	—	58
59[3]	15	203555	6200	33	Anth. Buckwheat.	Ex	C	V	—	—	—	—	59[3]
60	14	762825	20700	37	Bit. Slack.	Exy	C	V	5.44	—	—	—	60
61	15½	806880	19300	42	" "	Exy	C	V	5.78	—	—	—	61
62	18	1294708	31040	42	" "	Ex	C	V	4.23	—	—	—	62
63	16½	866235	20500	42	" "	Exy	C	V	5.75	—	—	—	63
64	14	1454656	31739	46	Bit. No. 2 Nut.	Cx	JB	V	5.48	6.5	6.85	—	64
65	14½	1881102	31992	59	" "	Cx	B	V	5.8	7.1	7.48	—	65
66	24	194472	3300	65	Wilmington Lump.	(1E, 7C) x	C	C	—	—	—	—	66
67	8	444133	6101	73	Bit. Slack.	Ex	C	V	4.66	—	—	—	67
68	14	1201483	15386	78	Bit.	C	C	Alt.	—	—	—	—	68
69	10	506937	6296	80	Bit. Slack.	Ex	C	V	5.59	—	—	—	69
70	24	5982000	71000	84	Bit. Screenin	(6D1E5Dz)x	A	V	—	—	—	—	70
71	14½	1243441	14224	87	Bit.	C	C	Alt.	—	—	—	—	71
72	14	477425	5400	88	Semi-Bit.	Ex	C	Alt.	9.68	10.7	11.13	37	72
73	24	2879000	31200	92	Bit. Screenings.	Dxz	A	A	—	—	—	—	73
74	13½	1217000	12895	94	Anth.	Ex	C	V	—	—	—	—	74
75	24	1960973	17600	111	Bit.	Ex	C	V	—	—	—	—	75
76	24	3360065	20300	166	½ Ea. Anth. Bit.	B	A	Alt.	6.82	7.89	9.20	—	76
77	24	3373305	20300	166	" "	B	A	Alt.	6.2	7.14	8.33	—	77
78	24	3398595	20300	167	" "	B	A	Alt.	6.6	7.56	8.82	—	78
79	24	40233030	213000	189	Bit. Screenings.	A	A	A	—	—	—	15½	79
80	24	1404089	8700gals	1717[6]	Crude Petroleum.	D	2B, 3C.	B	—	—	—	—	80
81	24	3455088	19400	181	Semi-Bit.	(A.D.E)xy	C	V	10.5	—	—	—	81
82	24	5761915	40800	141	3 Slack 1 Nut.	1D, 2B	B	V	—	—	—	—	82

NOTES.—[1], [2], [3]; See Load Line Chart [1], [2] or [3], the load line bearing same number as report.
[4]; Average from one years' record.
[5]; Total for one month.
[6]; Per gallon of oil.

Equipment Letters denote classes as follows:
A. Engines, triple expansion condensing. Boilers, horizontal water tube. Dynamos, multipolar on engine shaft.
B. Engines, Corliss compound condensing. Boilers, vertical water tube. Dynamos, bipolar, belted from jack shaft.
C. Engines, simple Corliss, or slow speed condensing. Boilers, horizontal tubular. Dynamos, continuous current.
D. Engines, high speed compound condensing, belted direct to dynamo.
E. Engines, simple high speed condensing, belted direct to dynamo.
x. Any of the above non-condensing.
y. Belted to dynamos.
z. Dynamo on engine shaft.

to construct load lines from 22 of the stations reported, the lines being presented in Figs. 1, 2 and 3, each line being numbered to correspond with the number of the report. Economies are given from a number of the largest electric stations in the country, five of them having an output of over 10,000,000 watt hours per day, and 45

*Report of the committee on Data of the National Electric Light Association. Presented at the New York meeting, May 6, 1896.

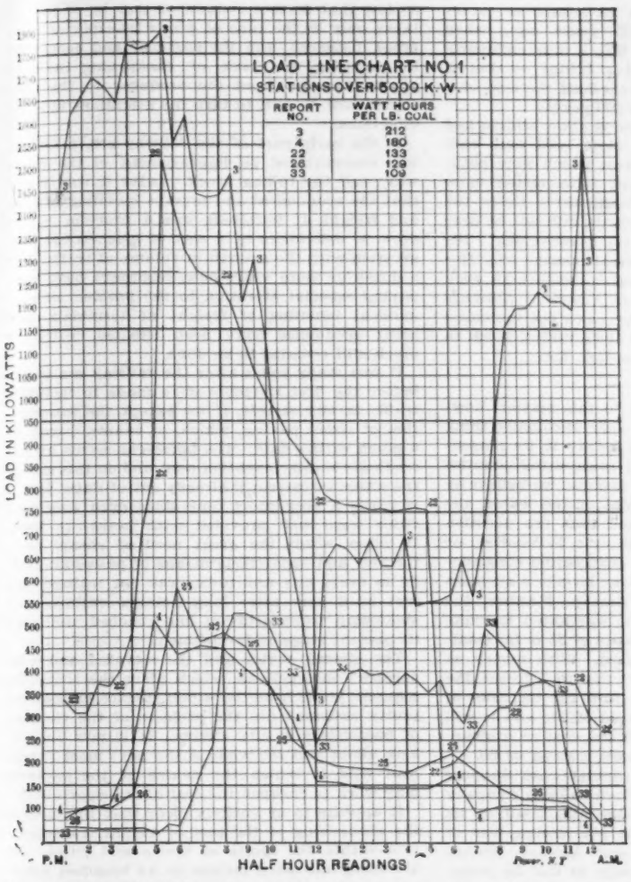


FIG. 1.—DIAGRAM SHOWING VARIATIONS IN LOAD FOR 24 HOURS IN ELECTRIC LIGHTING STATIONS WITH A CAPACITY OF 5,000 K-W. AND OVER.

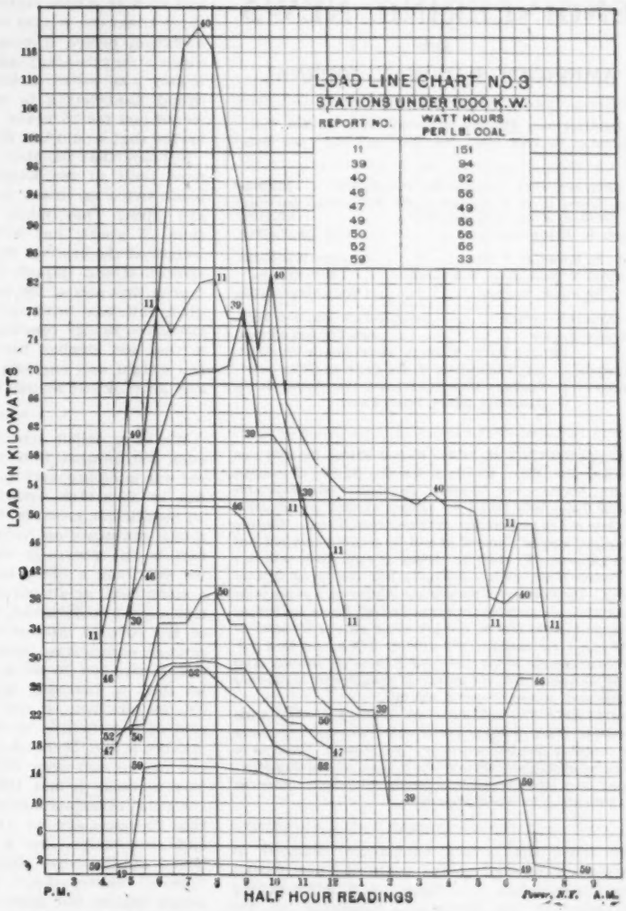


FIG. 3.—DIAGRAM SHOWING VARIATIONS IN LOAD FOR 24 HOURS IN ELECTRIC LIGHTING STATIONS WITH A CAPACITY UNDER 1,000 K-W.

sumption per indicated horse power. The triple expansions lead in economy, report 80 showing a consumption of 15½ lbs., and report 3 showing 18 lbs. of water per indicated horse power; these comparing reasonably with report 29 where an indicated horse power is produced by non-condensing engines with 26 lbs. of water. Report 22 in the table of economies submitted at the last convention, showing a production of 262 watts per pound of coal, and having the highest economy in the stations mentioned in that report, is from the same station as report 3 in the present table, and which in point of economy stands third on the list; the economy being 212 watts per pound of coal, a showing somewhat inferior to the previous report. The station is reported in a general way as running at greater economy than when the previous report was made. The efficiency figures, however, would seem to contradict this statement and to verify the statement in the present report. In the previous report 9.37 lbs. of water were evaporated per pound of combustible, and 17 lbs. of water consumed in the engines per horse power. The present report brings the evaporation per pound of combustible down to 8.81 lbs. of water, and the steam consumption in the engines is raised to 18 lbs., which would account for the lower efficiency stated in the present report.

Attention is called to the reports from plants running with non-condensing engines, in which report 26 (see load line) is able to show 129 watt hours per pound of coal; report 32 (see load line), 113 watt hours; report 33, 109 watt hours; report 37 (see load line), 100 watt hours; and report 38, 95 watt hours. While Nos. 39 (see load line), 43, 50 (see load line), 68 and 71, running condensing, produce respectively only 94, 68, 33, 78, and 87 watt hours; this showing and other features of the report proving conclusively that it is as much a question of management and manipulation as of the type of machinery used.

In conclusion we are lead to repeat a former statement by this committee that the economy secured in generating power for electrical work does not compare favorably with the production of power for other purposes, and that this is also true after taking into consideration the variation in load due to electrical work. Referring to a recent statement of the economy of the Chestnut Hill Pumping Station at Boston, it was found that in actual water lifted a horse power was produced by the consumption of 1.34 lbs. of coal; allowing that the efficiency of pumps compares favorably with the efficiency of the generators, and making no allowance for variation in load, one pound of anthracite coal used with the same economy in electrical work should produce 557 watt hours. Our load line charts show a fair average of the variation in electrical work, line three, chart one, dropping from 1,800 K-W. at 6 p. m. to 250 K-W. at midnight; yet the changes seem, as generally true in electric lighting, to be fairly uniform, and a station planned with the proper units for the work should operate the much larger percentage of its generating appliances on a fair basis of economy, bringing the record in this work much nearer the standards of efficiency in other lines.

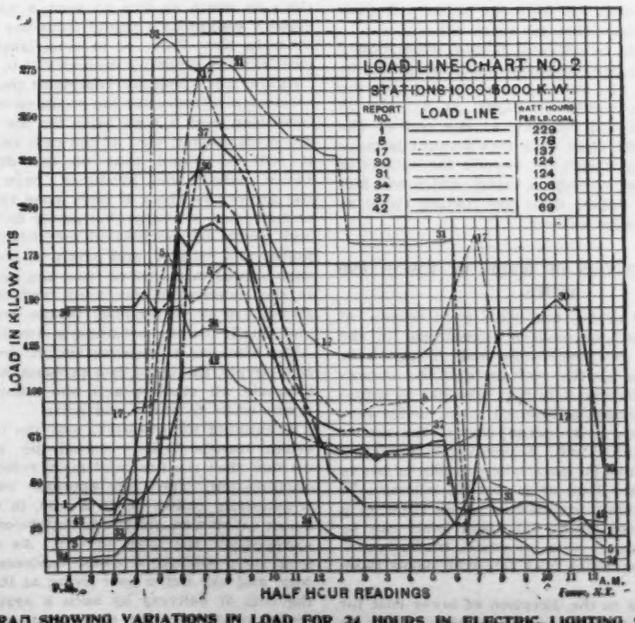


FIG. 2.—DIAGRAM SHOWING VARIATIONS IN LOAD FOR 24 HOURS IN ELECTRIC LIGHTING STATIONS WITH A CAPACITY OF 1,000 TO 5,000 K-W.

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We trust that every contractor engaged in sewer work, as well as the engineers who design it, will appreciate the value as a labor-saving instrument of the tables and diagrams for use in making estimates of sewer excavation which are published in our inset sheet this week. They are so simple that any one can easily understand them and learn to use them, and the saving of time as compared with the ordinary method of arithmetical computations is so great that any one who once becomes accustomed to use the diagrams will never return to the old method. For the benefit of those who desire these diagrams in a more convenient form than that of our inset sheets, we shall shortly republish Mr. Swaab's paper in pamphlet form, with each diagram on a separate page.

Our London contemporary, "The Engineer," in an elaborate editorial on "The Life of Iron Railway Bridges," exhibits its usual tendency to depreciate American bridges as of "flimsy construction," and to laud English bridge-building practice. We quote as follows:

> So far back as half a century ago we did not build iron railway bridges of flimsy construction. Foreign experience has proved that in structures of the class referred to an existence of 25 years, short as it appears, was a very fair life, for as often as not bridges succumbed before the full score was attained. On the Baltimore & Ohio line all the bridges erected prior to 1878 have either been strengthened by additional metal, by extra girders, or temporarily supported by scaffolding pending construction.

In our opinion, if the American bridge builders of 25 years ago built their bridges of such "flimsy construction" that they required either stiffening or entire rebuilding at the end of 25 years, they proved themselves not only good bridge builders but good financiers.

Let it be remembered that during that 25 years the weights of cars and locomotives have been increased to twice or thrice what they were when the bridges were built; also that during the same period the cost per pound of railway bridges has been reduced more than half, and the rate of interest on railway bonds has suffered almost the same reduction.

It was exceedingly good bridge-building to design a railway bridge with such good proportions and such an ample factor of safety that it carried three times the weight for which it was originally designed, before it became so unsafe as to require strengthening; and 25 years ago, when money was worth at least 6%, it was eminently sound financiering to build a bridge so that it would last for 25 years, at one-half the cost of a bridge that would last 50 or 100 years.

Suppose that the Baltimore & Ohio bridges had been built in the English style, and had been made twice as strong as those which were actually built. They might then have lasted more than 25 years; but with loads three times the weight of the original they might still not be considered strong enough for the present day. The fact is that one of the principal reasons why English railways have not had to undertake such extensive bridge renewals as American railways is that the English railways have not increased the weight and capacity of their rolling stock to any such extent as has been done here.

We have called attention to this matter, however, not because it is any very uncommon thing for our contemporary to go astray in its reasoning, or to attack American engineering practice on insufficient grounds; but because we believe by many engineers on both sides of the water, the fact is not generally realized that the question for how long a life a bridge or a locomotive, or a steamboat, or almost any engineering construction should be designed, is very largely a question of the rate of interest on money. Further, the present expenditure which is warranted to make a structure last 50 years instead of 25 is far smaller than is generally supposed. With money at 5%, for example, it will not pay to increase the cost of a structure by one-third for the sake of making it last 50 years instead of 25; and it will not pay to add even 10% to the cost of a structure to make it last 100 years instead of 50.

We may illustrate this by a concrete case. Suppose that 25 years ago an American railway company had two designs for a bridge submitted to its board of directors. Suppose one design was of "flimsy construction," as our English friends would call it, but good enough to last 25 years, the other of English design, solid and substantial, good for 50 years or more. Say the price of the first is $100,000 and of the second $200,000. Money being worth 6% per annum, the directors might weigh the merits of the two designs as follows: "If we build the $100,000 bridge we shall save in interest $6,000 per annum. Let us put this into a sinking fund at 6% for 25 years. An annuity of $6,000 at 6% for 25 years will amount to $329,190. That is to say, at the end of that time we will have that amount of money to build a new bridge with, which will be a far better one than the English bridge then 25 years old.

The case might be different to-day, when money to a railway in good financial condition might be worth only 4%. The annuity saved by building the cheaper bridge would be $4,000 at 4% for 25 years, which would amount, at the end of the time, to $106,632. But even this amount is large enough to make it still not beyond the bounds of good financiering to build a bridge which will last only 25 years, rather than one costing twice as much to last twice as long.

THE TRANSPORTATION OF GOODS IN TOWNS AND CITIES.

The world is proud, and with good reason, of the achievements of modern engineering in the transportation of passengers and freight over great distances by the railway and the steamship. By the former it is now possible to transport a ton of freight a hundred miles, under favorable conditions, at an actual cost to the carrier as low as 20 or 25 cts. A passenger is carried the same distance on lines where traffic is heavy and journeys are long at a cost of, perhaps, 75 cts., under ordinary conditions, or as little as a third of this sum where full train loads can be moved. By lake or river or ocean, traffic is carried on at a cost which may fall even below these figures.

That progress in the direction of lower cost for long distance freight and passenger traffic is at an end, no one believes. At the same time it is true that these figures have now been brought so low that further reductions can be of importance only in the case of goods transported over great distances, and the engineer and economist in pursuing the task of cheapening the cost of the transfer from the producer to the consumer, will do well to turn his attentions in other directions.

In the early part of the railway era, attention was concentrated on improvement of the roadway and the rolling stock. Later it was found that the economical and prompt handling of cars and freight at terminals was a problem which grew in difficulties by a sort of geometrical progression with the growth in volume of traffic. For a dozen or more years now, engineers have been paying especial attention to the problem of economical handling of freight at terminals, and great economies have been effected, although much still remains to be done.

It was many years after the railway era began before the first attempts were made to facilitate traffic in city streets, if we except the introduction of street paving, which, of course, began at a much earlier date. The horse-car seems an exceedingly simple invention now, and on this side of the water we esteem it already out-of-date; but it is really a very short time since even American cities were well provided with horse-car lines. In other words the great need of cheap, comfortable and expeditious means of passenger traffic in every city and town, was not realized and met until long after long-distance railway and steamship transportation had reached well-nigh its present stage of development.

The electric motor and the elevated and subsurface constructions, which place the tracks on different levels from the street surface, have solved pretty satisfactorily the problem of the carriage of passengers in city streets. It is now time to look about and see what is the next most important field in which the genius of the engineer may work to cheapen the cost of transportation.

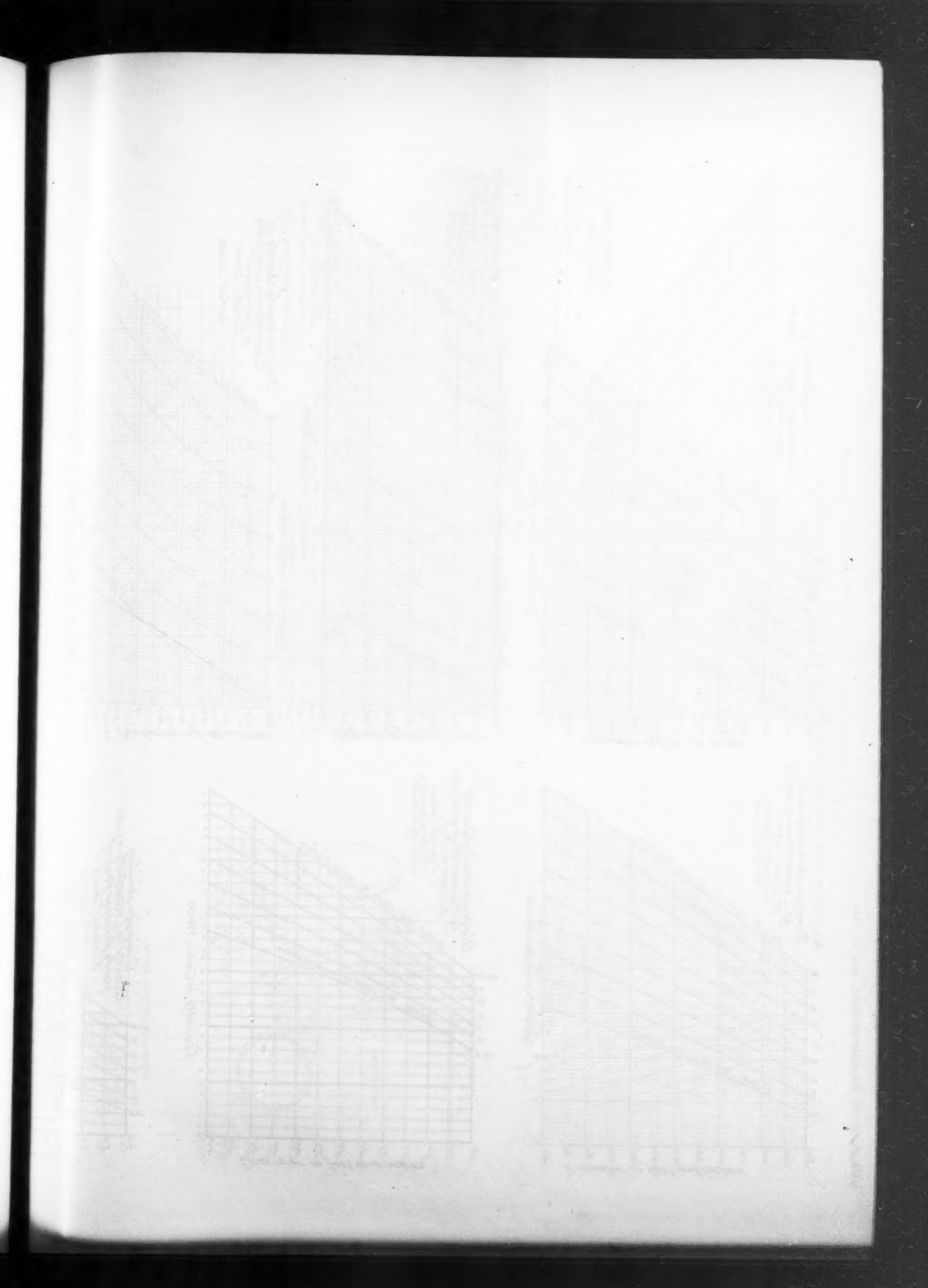
It appears to us entirely clear that this field is the cheapening of the cost of freight transportation within the limits of towns and cities. We are using the word freight in its broadest sense, as meaning every class of goods, from such bulky products as coal and flour to the spools of thread and skeins of silk of the dry goods store, and the soap and tea of the grocer.

It is doubtless not generally realized that the methods in use for the transport of goods in towns and cities are in reality antiquated and in many respects exceedingly expensive. We have pointed out above that a ton of goods may, in some instances, be carried by rail a distance of a hundred miles at a cost as small as 25 cts.; but it costs as much as this to send a package of as small a weight as a pound from one point to another in New York, or in most large cities, if a local express company is employed to do the work.

Again, it is a common complaint that the farmer receives a pittance for his products while the city consumer pays a high price for his fruits, green groceries, butter, etc. If the case be investigated it will be found that of the difference between what the producer pays and what the grower receives, a trifle goes to the railway and the rest is chargeable partly to the expenses and profits of commission merchant, wholesaler, jobber and retailer, and partly to the cost of the various wagon transfers from the railway station to the commission merchant, and thence to the storehouse or warehouse, to the retailer's store and finally to the consumer's dwelling.

The cheaper transportation of goods through city streets, therefore, is a problem which directly interests all classes, and one which it is well worth while to study and solve.

Examining the question, why the cost of interurban transportation should be so excessive, we find that the first and main reason is lack of organization. The "city express" business, as it is generally called, is, as a rule, in the hands of a poor set of men, one grade better—or perhaps one worse—than the hack drivers. As a rule these men each conduct a small business in a small way, and eke out a poor living at it. Manifestly the cost of delivery by such a system must be great; practically the expressman makes a spe-



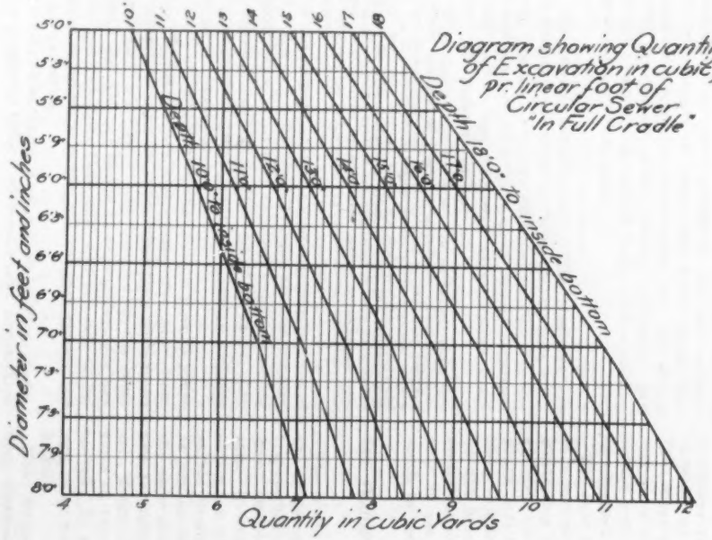


Diagram showing Quantity of Excavation in cubic yds. pr. linear foot of Circular Sewer "In Full Cradle"
Depth 18'-0" to inside bottom
Depth 10'-0" to inside bottom
Diameter in feet and inches
Quantity in cubic Yards

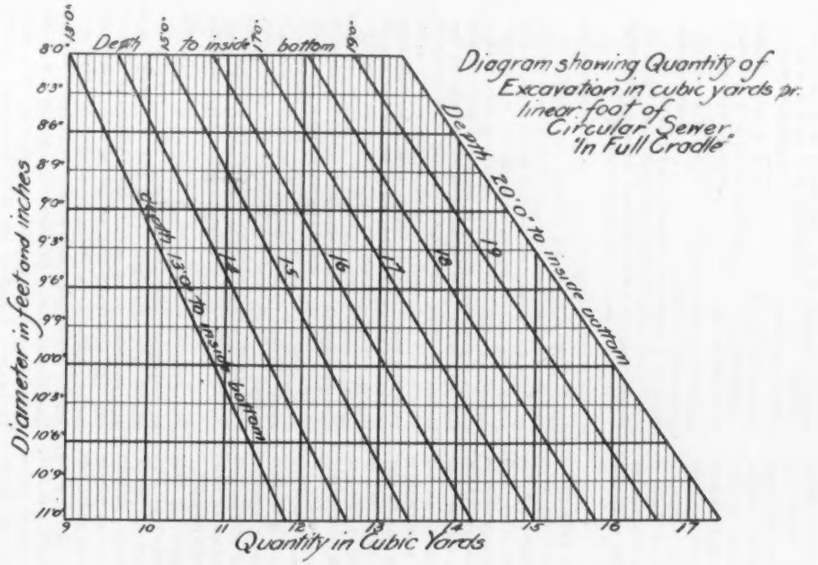


Diagram showing Quantity of Excavation in cubic yards pr. linear foot of Circular Sewer "In Full Cradle"
Depth 20'-0" to inside bottom
Depth 13'-0" to inside bottom
Diameter in feet and inches
Quantity in Cubic Yards

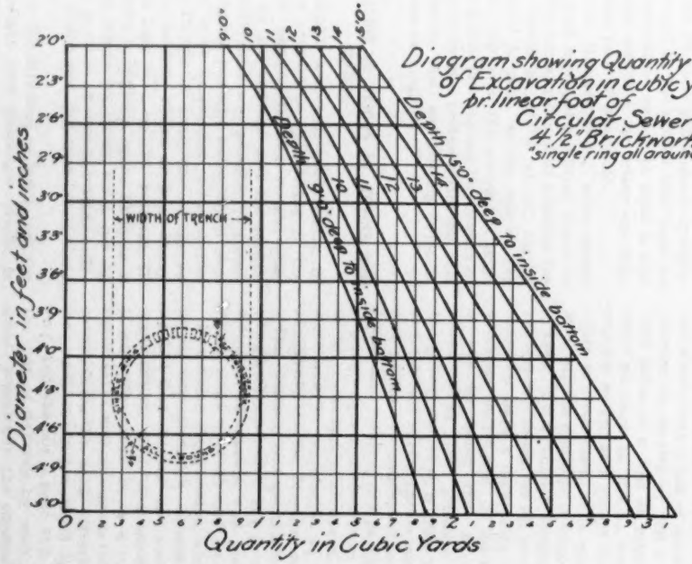


Diagram showing Quantity of Excavation in cubic yds. pr. linear foot of Circular Sewer 4½" Brickwork "single ring all around."
Depth 15'-0" deep to inside bottom
Depth 9'-0" deep to inside bottom
WIDTH OF TRENCH
Diameter in feet and inches
Quantity in Cubic Yards

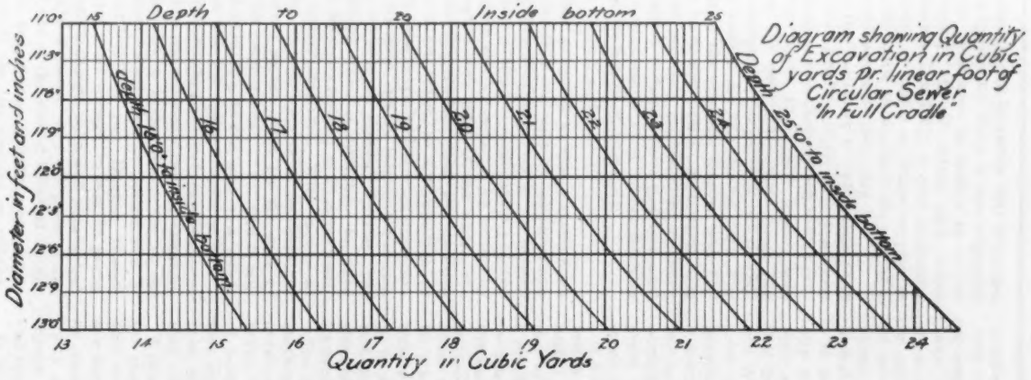
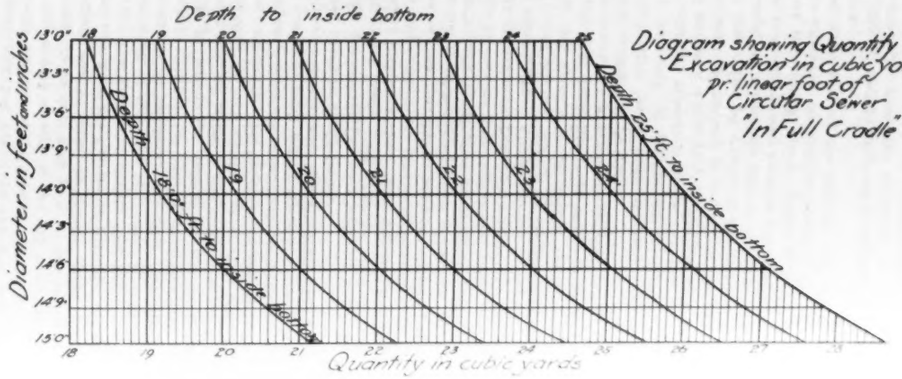


Diagram showing Quantity of Excavation in Cubic yards pr. linear foot of Circular Sewer "In Full Cradle"
Depth 25'-0" to inside bottom
Depth 18'-0" to inside bottom
Diameter in feet and inches
Quantity in Cubic Yards


Depth to inside bottom
Diagram showing Quantity of Excavation in cubic yards pr. linear foot of Circular Sewer "In Full Cradle"
Depth 25½ ft. to inside bottom
Depth 18'-0" to inside bottom
Diameter in feet and inches
Quantity in cubic yards

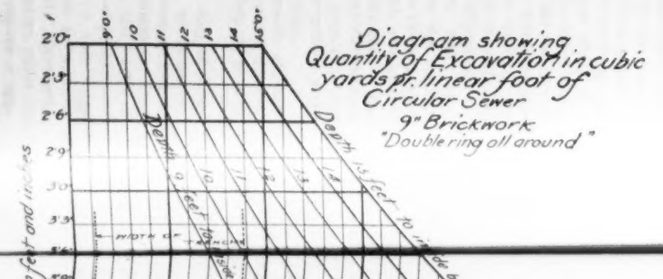
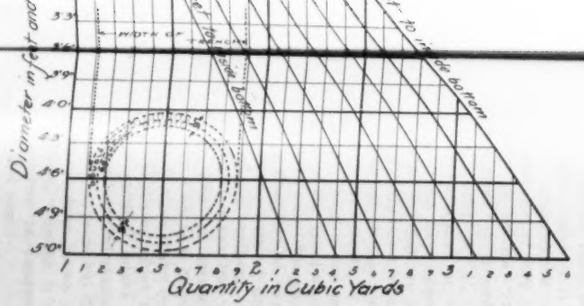


Diagram showing Quantity of Excavation in cubic yards pr. linear foot of Circular Sewer 9" Brickwork "Double ring all around"
WIDTH OF TRENCH

Diagram showing quantity of
pr. linear foot of
Egg Shape Sewer
"In Full Cradle"



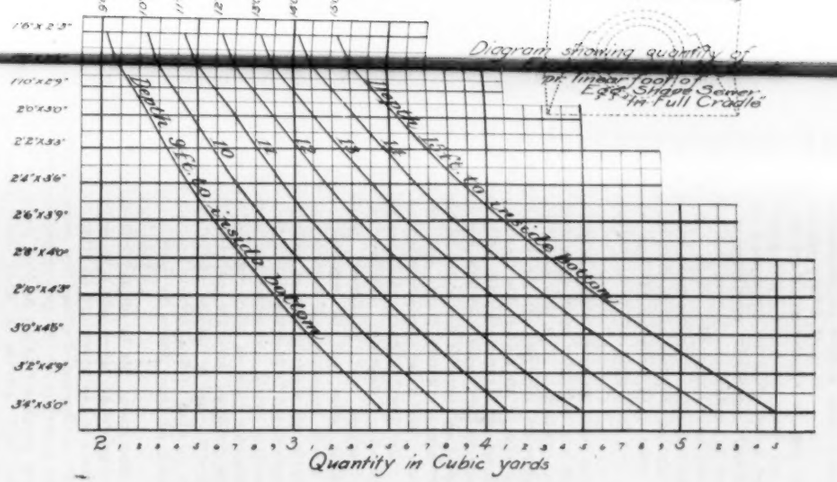
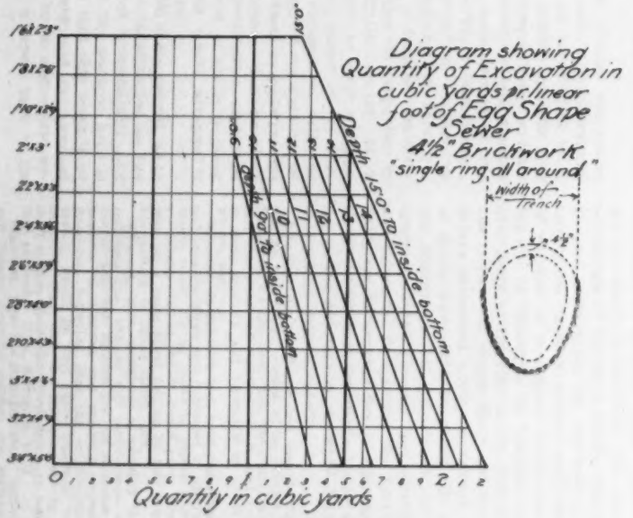
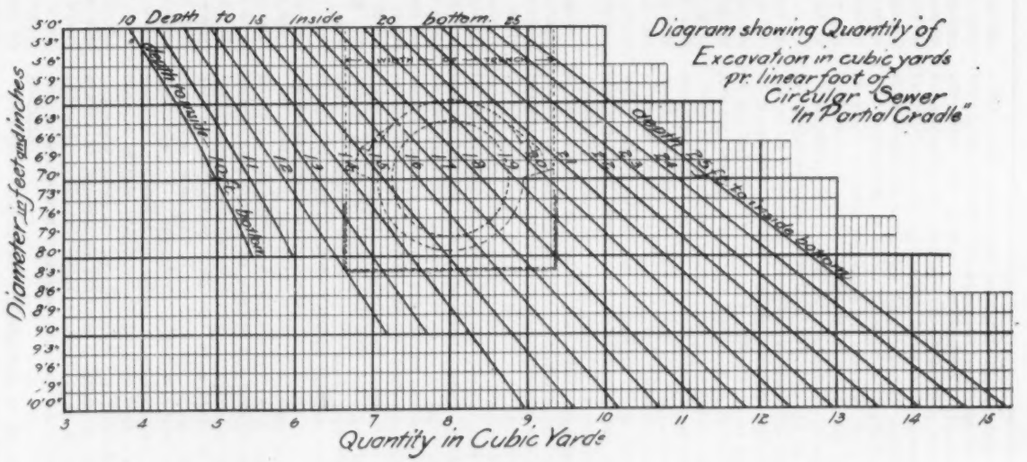
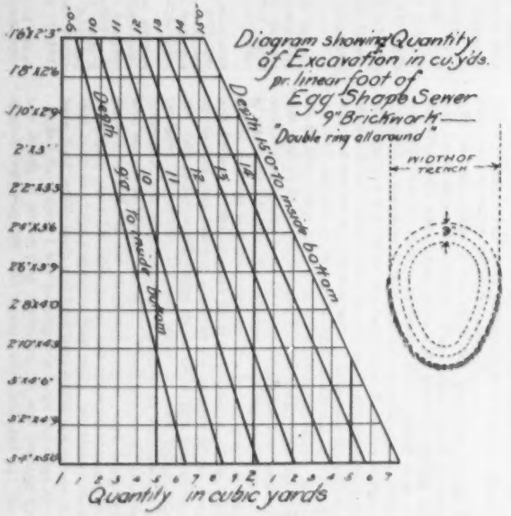
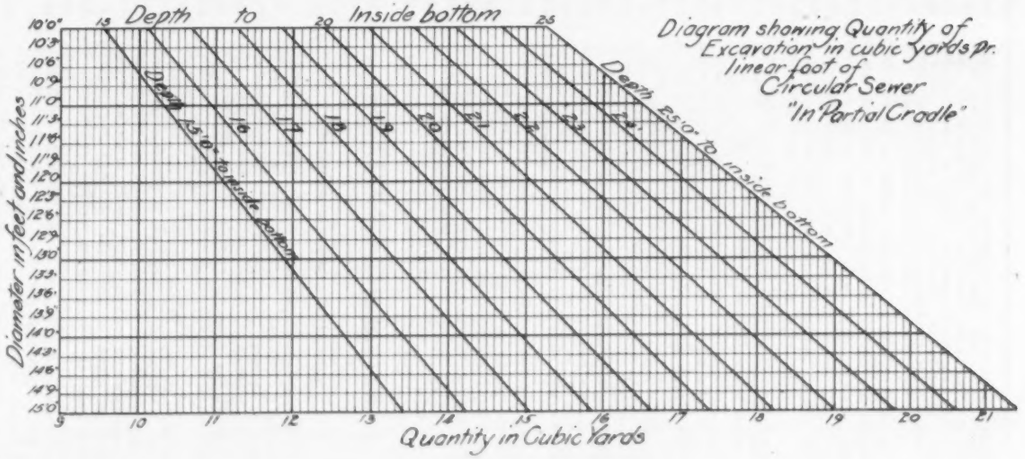


Diagram showing quantity of
pr. linear foot of
Egg Shape Sewer
in Full Cradle
Depth 9'6" to inside bottom
Depth 15'0" to inside bottom
Quantity in Cubic yards









DIAGRAMS FOR THE COMPUTATION OF ESTIMATES FOR SEWER EXCAVATION.*

By S. M. Swaab, Civil Engineer, Philadelphia, Pa.

* Copyright, 1896, by S. M. Swaab.

cial journey for every order. A large part of the business of these expresses is the collection and delivery of baggage to and from railway stations; and this has been systematized to a considerable extent in the large cities, where it is largely in the hands of large express or transfer companies. These have secured an advantage over their competitors through the privilege of placing advance agents on incoming railway trains; and they are able to do business on such a large scale as to make handsome profits from it.

But all the traffic movement of this class is, after all, but a trifle, compared with the movement of the necessaries of daily living from retail stores to consumers' dwellings. The carts of the butcher and grocer and baker, of the purveyor of dry goods and china, furniture and hardware—these and others of a similar sort it is that form the bulk of the traffic to and fro in the city streets; and the question is to what extent this distribution may be simplified and cheapened.

Suppose that a single company were to undertake the work of package collection and distribution for an entire city in a systematic manner. It would first divide the city into districts, each, let us say, a half mile to a mile square, more or less. In each district would be located an express station, and in a large city all these stations would be connected by switches to an electric railway line. Each district would have its staff of delivery wagons, carts, etc., and these would make their rounds over the entire district at regular intervals, collecting on every street packages for shipment and delivering packages at the same time. Arrived at the station the packages would be assorted according to the districts for which they were destined and dispatched at regular intervals. If the electric car connection above outlined were in use, trolley cars could be kept continually on the rounds between stations, stopping at every station merely long enough to take off what was destined for that station, and to take on its shipments, the sorting of which could be done while the car was running.

That the distribution of the great bulk of the parcel express of a city could be effected in this way as promptly as at present and at a small part of the expense, will hardly be questioned. Of course heavy and bulky articles, or anything which it cost as much to load as to transport would be excluded from such a service. The furniture dealer and the vendor of plate glass would still send his own wagons to deliver his goods. So, too the butcher and the grocer who supply customers in a limited neighborhood, and make regular morning calls upon their customers to take orders, could not make use of the services of such an organization.

But after these and other similar exceptions are deducted, there still remains a great volume of traffic which if it could all be handled by a single organization would render possible the introduction of very great economies and greatly improved service. The delivery wagon feature of a great department store, such as that of Hilton, Hughes & Co., in New York; Wanamaker, in Philadelphia, or "The Fair," in Chicago, is one of the most expensive adjuncts to carry on, and yet the delivery service of such an establishment costs but a small fraction (in proportion to the sales) of the cost of similar service to a firm with a tenth or a fiftieth as large a trade. In fact this is one important factor in the success of the great stores in competition with the smaller ones. The great dealers have a volume of sales great enough to enable them to make prompt deliveries without great expense. But no store not doing business on a considerable scale can afford to make free deliveries at all in a great city, and the smaller stores which attempt it carry it on at a disadvantage.

Much more might be said did space permit, as to the details by which such an organization as has been outlined might be most economically and efficiently administered; but the purpose here is merely to point out the fact that this work is at present done in an inefficient and extravagant manner, whereas it might by a systematic organization be conducted at a small part of its present cost.

We may also with especial appropriateness here point out the advantage to be gained by the adoption of better mechanical appliances for carrying on work of this class. The manner in which electric cars might be utilized in such a distribution system, we have already outlined. The adaptation of motor wagons to the delivery of goods is well indicated by the fact that the first users of such vehicles in this country were the department stores of the great cities. It seems altogether probable that these vehicles will, in the course of a very few years, be so perfected as to be applicable to city express service, especially of the lighter sort, and will carry it on at much less cost than it is at present carried on by horses.

The small parcel carriers of the tricycle style, propelled by the rider, are more and more commonly seen in city streets and for the delivery of light weight packages, have undoubtedly a wide field of usefulness, especially where grades are light and streets are well paved. We may remark here that the rapid increase in this class of vehicles and in bicycles and motor wagons, is certain to cause an increased demand for smoother pavements, and to lead to asphalt being favored instead of stone. Some indication of the direction in which progress is tending is furnished by the recent establishment of a new journal with the unique title of "The Horseless Age." Without looking too far in advance, it is at least clear that the claims of those who desire smooth pavements for easy traction are as much entitled to recognition as are the claims of those who desire a pavement which will give the best foothold for horses. When the horseless age really comes, we shall certainly have no further need of pavements laid with joints.

Returning to the subject of mechanical appliances for use with an organized system of parcel distribution, it may be pointed out that an electric or pneumatic dispatch system might be operated in connection with the local stations for the more rapid and prompt transfer of parcels of small size. The pneumatic system has been used enough to make it no longer an experiment. By the use of this system, in connection with a special messenger service mounted on bicycles, it should be possible to transfer a letter or small packages from one point to another in a large city in much less time than by any means now available.

Doubtless if such an organization as we have outlined were once established, it would find it profitable to enlarge its field still more widely than we have indicated. A large part of the heavy trucking of a city would fall into its hands. In England the railway companies deliver all freight to the consignees as American express companies do in large cities. American railways are not likely to introduce this custom; but the advantage of having a single systematically organized service for the carriage of freight between the railway station and the warehouse of shipper or consignee should be evident. In the city of Brooklyn, the burdens upon the manufacturers of the city in the shipment of goods, due to the long wagon hauls and the expense and delays attendant upon the receipt and delivery of goods have long been felt. A committee of the Manufacturers' Association of Kings and Queens counties recently investigated the matter and succeeded in inducing the Brooklyn Heights R. R. Co. to arrange for the operation of an express service over its lines. At the annual meeting of the Association, on April 20, the following resolutions were adopted:

Whereas, the merchants and manufacturers of Brooklyn, as well as all classes of its citizens, are materially hampered by the fact that the interchange of natural and manufactured commodities to and from other cities is more dilatory and expensive in Brooklyn than elsewhere, and,

Whereas, In January last, your committee on commerce and transportation was requested to ascertain if arrangements could not be made to secure improved facilities in transportation which would place Brooklyn business men on a more equal footing in this respect with their competitors in other cities, and,

Whereas, This committee is satisfied that the surface railroads can, without any interference with their passenger business, furnish the car facilities for a comprehensive, economical and superior express system in Brooklyn, believing that the establishment of such a system would be even more beneficial to all Brooklyn interests than has the improvement in United States mail service since the introduction of mail cars on surface railroads. Now, therefore, be it

Resolved, That the Manufacturers' Association of Kings and Queens counties petition the surface railroad companies to arrange a car service for the handling of express goods and packages, market products and personal baggage throughout the city and contiguous points to be combined with a system of wagon collections and deliveries, to enable the merchants, manufacturers, and taxpayers in Brooklyn and its suburbs to more successfully compete with those of other cities.

So far as we know, this is the first definite attempt toward the introduction of such a system as we have outlined. Its progress will be watched, therefore, with much interest. The only details of the plan that have reached us are the following from the "Eagle," of April 21:

The Brooklyn Heights Railroad company has just made a contract with the National Express company under which its entire railroad system in addition, of course, to carrying its passengers as at present, will be used in the express business in somewhat the same way that the steam railroads are utilized on a larger scale.

Under this contract express cars are to be put upon trolley roads. A dozen or fifteen of the car houses of the railroad company will be made branch express offices.

By telephoning to the nearest car house, where a branch express office will be located, anybody can have trunks, parcels, packages of all kinds and every class of high class express matter called for at his residence or place of business by a wagon. This wagon will take the goods to the branch office. From there it will be distributed to any point in the city or taken to any of the railroad lines or piers, wherever, indeed, the sender may wish to have it delivered.

We shall be pleased to learn of the introduction of similar enterprises in other cities, for we are convinced that there is no more promising field than this in which to work to lessen the cost of transportation.

LETTERS TO THE EDITOR.

The Costliness of Cheap Engineering.

Sir: I think your valued paper could do much good for cities, contractors and competent engineers by calling general attention to the wrong which cities do to their own interests and to contractors by employing incompetent engineers and by altering the plans and specifications of competent engineers to suit the funds which they have available for the work.

These alterations are almost always made by so-called engineers, unworthy of the name, at the request of contractors who are bidders for the work and wish to make sure of getting it. These contractors are as a class much sharper men than the engineers in charge of work in small cities, and are generally able to carry their point.

Another root of the present trouble is the existence of a class of engineers who are fiercely competing with each other for city work, and their only chance of success is to show the city employing them that the work can be done for a low figure. They sacrifice everything to do this and force the contractor down so low that his only chance of coming out whole lies in skimping the work.

To illustrate some of the methods resorted to to beat the contractor, I will give one instance from my own experience. Not long ago a contract was let for a system of water-works for a southern town. There were 52 bidders on the ground. My own expenses were $154, and few of the contractors who bid on the entire work got off with less. My bid was down to bed-rock, $65,000, and was the lowest. I was then calmly informed by the President of the Board that on the next day they would ask each bidder how much he would cut his own bid. That night on going over the figures I found that my bid carried a profit of $1,000, provided all panned out right, and provided I could get a margin of $1,200 on the standpipe, boilers, valves and hydrants.

On the afternoon of the third day after the letting I was called before the board. They asked me if I could give them the advantage of the bids made separately on standpipe, boiler, valves, hydrants etc. I asked them if I could use the same bids in connection with mine. They said yes, if I gave them the difference. I then told them what a small amount was in the work for me and that they had not done as they agreed. I being the lowest bidder was entitled to the work, and demanded my check for $2,500. They gave it to me after some demur, and I was glad to be out of the affair. The result was that the works were poorly built and the contractor lost between $18,000 and $20,000. He believed what the city's incompetent engineer told him, and the city gained a few thousand dollars at the expense of the contractor. Now I do not believe that there is a city in the country whose people wish to rob a contractor or to make him lose money in doing city work; but our cities do need thoroughly competent and conscientious engineers as advisers—men who cannot be bought and sold. There are plenty of such men to be had. If our cities will rely on such engineers to prepare plans for their work, and allow no changes except such as these engineers may make, we should then have good public work and tricksters would not bid on it.

A few days since I was looking at a large sewerage system which is worse than worthless. It was planned by a good engineer, but the plans were changed by one

who was unworthy to unlatch his shoestrings, and the taxpayers have to suffer for such disgraceful foolery.

Yours very truly, "Contractor."

April 30, 1896.

A Formula for Finding the Meridian by a Single Solar Observation.

Sir: In finding the meridian by a single solar observation, surveyors in this locality use the following formula:

$$\text{Cos } \tfrac{1}{2} \text{ az} = \sqrt{\frac{\text{Cos S cos (S} - \text{P. D.)}}{\text{Cos L cos h.}}}$$

Where az=sun's azimuth measured from the north.
P.D.=sun's polar distance, or co-declination.
h=sun's altitude minus correction for refraction.
S=Half sum of polar distance, latitude and true altitude.
L=Latitude of place of observation.

In this formula there is only one subtraction (for the polar distance) and all the other quantities are used directly, while in the formula given by Prof. Johnson in your issue of March 19, 1896, three subtractions are necessary, thus increasing the liability of error.

Evanston, Wyo., March 23, 1896. W. Newbrough.

Sir: The method of determining the meridian from a single observation on the sun, as described by Prof. Johnson in your issue of March 19, is one which is rapidly superseding the use of the solar attachment in making U. S. mineral surveys. On account of the difficulty of accurately adjusting so small an instrument as the solar attachment the results obtained by the use of it are more apt to be in error than are those obtained by a direct observation with a transit in perfect adjustment. The "direct sight" can be more rapidly taken than an observation with a solar attachment, but it necessitates computations which the latter does not. These, however, can be made in the office, unless a line of a known bearing is to be rerun, in which case the meridian must be determined in the field.

For a transit giving an erect image no extra attachments are required for the direct sight, the image of the sun formed by such an instrument being small enough to be received upon a card and accurately bisected. But when an inverted image is formed by the telescope a colored glass attachment should be used, as the image thus formed on a card is too large to be accurately bisected. The colored glass should be attached to the eyepiece and not to the objective.

It is more convenient to employ in the computations, φ, the latitude of the place and δ, the declination of the sun, rather than the co-latitude and co-declination. By substituting these terms the formula becomes

$$\text{Cos } \tfrac{1}{2} \text{ A} = \sqrt{\frac{\sin\left[\frac{180^\circ + z - \delta - \varphi}{2}\right] \sin\left[\frac{z + \delta - \varphi}{2}\right]}{\sin \varphi \sin z}}$$

in which z = zenith distance of the sun corrected for refraction. Yours truly,

J. B. Guinn, C. E.

Cripple Creek, Colo., March 29, 1896.

Sir: The following communication is suggested by Prof. Johnson's article in Engineering News of March 19, 1896, upon finding the meridian by a single observation of the sun. Although his method is certainly convenient and useful, it is evident that any one possessing a solar attachment would use the attachment in preference. The construction of a solar attachment which can be had at a reasonable price is the great desideratum. Since the item which adds most to the cost of the solar attachment is the graduated arcs, the writer adopted the following devices whereby the necessity for graduated arcs, other than the ordinary vertical arc of the instrument, is avoided. A home-made attachment constructed upon these principles has been used with the greatest success. The devices are, first, to abolish the hour arc as not being an absolute essential, and second, to attach a delicate spirit level to the declination arm. The apparatus as made by the writer is extremely simple, being composed of a declination arm attached to the upper end of the polar axis, the polar axis resting in a holder which is attached by an adjustable universal joint to a clamp secured to the axle of the telescope. To prepare the apparatus for use the first thing is to set the declination arm at right angles to the polar axis. By virtue of the level tube on the declination arm this can be done by the method of reversion, which needs no explanation. After the arm is so set the telescope is made horizontal, the vertical arc set at zero and then an angle turned off upward equal to the co-latitude of the place. The universal joint is then shifted in different ways, without changing the relative position of the polar axis and declination arm, until the level tube indicates that the declination arm is level in all azimuths. When this is done it is seen that if the telescope is again levelled, not only will the polar axis be elevated at an angle equal to the latitude of the place, but that the vertical plane through the polar axis and the vertical plane of the telescope are parallel. The above results depend upon the fact that the declination arm has been set at right angles to the polar axis. Next, to set off the declination, the telescope is elevated at an angle equal to the co-latitude of the place minus the declination, and then the declination arm, while kept pointing in the same direction as the telescope, brought to the horizontal position without changing the polar axis. If the telescope is again levelled it is evident that three results have been secured: (1) that the polar axis is elevated at an angle equal to the latitude, (2) that the polar axis and the telescope point in the same direction, and (3) that the proper declination of the sun is set off. The use of the instrument is precisely the same as the ordinary solar attachment, the only requirement being that the telescope shall be brought to the horizontal position before sighting the sun. C. M. B.

Media, Pa., April 16, 1896.

Sir: Professor Johnson's description of a method of finding a meridian by a single observation, as mentioned in your issue of March 19, interested me considerably. The method he speaks of is the only one I have used since 1889. It is the best method I have ever heard of for quick work and accurate results. In 1890 a transit made for me was supplied with a prismatic eyepiece and a simple cap for the eyepiece containing colored glass to use instead of the prism when the sun was low enough to observe in that way.

Sometimes it has proved sufficient to observe the sun directly, but once in a while it has been convenient to hold a page of the field book back of the eyepiece a few inches and catch the sun's image on it. The shadow of the cross wires can then be made to quarter the sun's image. A friend writing in 1890, sends the following description of his method of finding the meridian with an engineer's transit by an observation on the sun:

A prism and colored glass at the eyepiece of telescope, or a colored glass cap on object end and prism on eyepiece will aid in taking the observations. Set up the transit with vernier on horizontal limb clamped at zero and needle pointing to magnetic North (zero). When needle becomes stationary clamp instrument and unclamp vernier, turn telescope on sun, quarter sun's image with cross hairs and clamp telescope and lower limb. Read vertical angle for sun's altitude and horizontal angle for sun's azimuth with magnetic North.

To reduce observations it is necessary to know the sun's apparent declination at the time of the observation, and the latitude of the place. The declination is taken from an ephemeris when the longitude is known. If the latitude is not known it may be found by an observation on the sun at noon and reducing altitude thus found, as follows:

r = refraction, always −, p = parallax, always +.
h' = sun's observed altitude. h = sun's true altitude.
z = true zenith distance. φ = latitude,
δ = declination ±.

$h = h' \pm (p + r)$. $z = 90^\circ - h$. $\varphi = z + \delta$.

Sun's Parallax in Altitude.

Altitude.....	0° to 12°	15° to 30°	33° to 39°	42° to 48°	51° to 57°	60° to 66°	69° to 72°	73° to 78°	81° to 84°	90°
Parallax.....	9″	8″	7″	6″	5″	4″	3″	2″	1″	0″

To Find the Meridian.

s = co latitude. z = co declination.
p = co altitude = true zenith distance.
θ = Sun's azimuth from magnetic North.
β = " " " true "

$$a = \frac{s + z + p}{2}$$

Mag. Decl. = $\beta \pm \theta$.

$$\text{Tan. } \tfrac{1}{2}\beta = \tfrac{1}{2}\left[\text{ar. co. sin a} + \text{ar. co. sin (a} - z) + \sin (a - s) + \sin (a - p)\right]$$

Check if β is a large angle.

$$\text{Cos. } \tfrac{1}{2}\beta = \tfrac{1}{2}\left[\text{ar. co. sin s} + \text{ar. co. sin p} + \sin a + \sin (a - z)\right]$$

Logarithms to be used.

The foregoing is copied from my letter book and the original is dated June, 1890. Experience has demonstrated that a colored glass cap on the object end of the telescope introduces large errors. The only reason I can give is that the plane sides of the glass are not parallel and therefore the light changes direction. A carefully made cap for experimental purposes gave good results but it was expensive. The best thing is a prism and colored glass over the sight. In making a survey I generally do angular work instead of taking needle readings. The observation for meridian is made whenever I happen to feel like it during the day. The evening before the sun's apparent declination is calculated for 9, 10 and 11 a. m., and 2, 3 and 4 p. m. An observation is made at one of those hours during the morning and another in the afternoon at an equidistant time from the meridian. Sometimes three observations are made in the morning and three in the afternoon, or perhaps only one in the morning and one in the afternoon. The taking of the observation is a simple matter and the reductions are made at any time afterwards. For instance on one survey two years ago, which occupied a week and was all angular work, I took two observations each day and reduced all the observations after coming back to the city. They agreed closely and a mean was placed on the map as the true meridian.

As Prof. Johnson says, the method is not new, but I do not remember seeing it mentioned in any text book on surveying. He will be doing surveyors a service if he puts it in his book. Yours truly,

Ernest McCullough,

Mills Building, San Francisco, Cal., March 26, 1896.

The Value of Air Spaces in Fireproof Construction.

Sir: I have read with much interest the articles by Mr. Seeley on fireproof construction in your issues of April 9 and 16. There has recently been introduced in this city a system of fireproof construction that embodies many of the improvements which Mr. Seeley has pointed out. By consulting the accompanying cuts, which illustrate the new system, it will be seen that a continuous air space averaging about 4 ins. in thickness is provided between the floors and ceilings (Fig. 1). By light iron false work these air spaces are carried around girders (Fig. 2) projecting below the level of the ceilings. The system also provides for connecting the air spaces around the columns (Fig. 3) with those between floors and ceilings, thus securing free circulation of air from one story to another throughout the building. The advantages of such a construction cannot be overestimated. It is economical, light in weight and very efficacious. Assuming a hot fire to break out in one or two rooms of a building fireproofed in this manner, the outer shell of plastered wire lath and light iron false work is attacked. The air between this plaster shell and the iron work is immediately heated, expands and a circulation is at once started which carries the hot air upward and draws the cooler air from the reservoirs beneath the floors. By reason of this air circulation the iron framework can only be heated by radiation from the outer shell—a very slow process. The very small amount of combustible material which a fireproof office or hotel building ordinarily contains would probably fail to maintain a fire a sufficient length of time to cause any serious injury to the ironwork where protected by this construction. For warehouses in which combustible goods are to be stored an extra heavy scratch coat of plaster should be worked through the meshes of the wire lath, so as to make a stratum of plaster at least 1 in. deep above the wire lathing. The air space between the plaster and the lower flanges of floor beams should be increased to at least 2 ins.

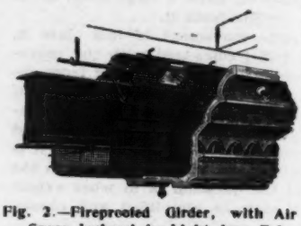


Fig. 2.—Fireproofed Girder, with Air Space Inclosed by Light Iron False Work.

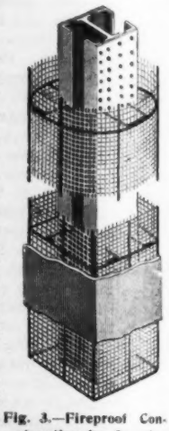


Fig. 3.—Fireproof Construction for Securing Air Chamber About a Vertical Column.

The proper arrangement and connection of air spaces is undoubtedly the correct method for the economic protection of ironwork. Yours truly,

A. L. A. Himmelwright, C. E.

117 Liberty St., New York City, April 23, 1896.

(The system referred to by our correspondent was described in our issue of July 18, 1895.—Ed.)

The Effect of Fire on Fireproofing Materials.

Sir: Some of the results of a fire and water test made by Howard Constable upon a building at Perth Amboy are of interest in connection with the opinions set forth by Mr. Seeley in his articles upon the "Art of Fireproofing," in your issues of April 9 and 16.

This test is particularly interesting as the floor tested was of larger size than usual and represented an entirely completed floor and ceiling ready for use with a distributed load of 170 lbs. per sq. ft. It was subjected to a fire of unusual intensity for over two hours, the temperature at the ceiling level reaching over 2,000° by the pyrometer. It also gives some comparative idea of the resistance to fire and water of common plaster, Portland cement, and patent plaster, as well as the transmission of heat through these various materials, as well as the strength, and fire and water resisting qualities of hard and porous terra cotta arches.

The accompanying photographs show:

1. That the terra cotta arches were uninjured and merely needed replastering, the common plaster with which they were covered being mostly washed away. When the arch blocks forming the floor were finally removed they had to be hammered down and had retained their original strength.

2. That the Portland cement on the wall A stood well and that the patent plaster on the wall B, and the plaster C was pretty well destroyed by the fire and water. The window D was closed up with hollow brick and fire clay just before the fire was started so as to make sure that the intensity of the fire would not be reduced suddenly by the burning out of the window.

3. The test was unusually severe because the room was piled over 4 ft. deep with dry pine and oak. It should be added that the room was fitted with an inlet for air at each lower corner and an outlet stack at each upper corner. The floors were covered with a grillage of brick so that the air could get under all parts of the firewood. Iron beams were put in the brickwork of the front and rear 12-in. walls and were protected in the front wall by 4 ins. of common brick and ⅝ in. of plastering and in the rear wall by 2 ins. of porous terra cotta. None of these beams disrupted the brickwork, nor was their temperature at the center raised to over 160°.

Table of Weights.

	Per sq. ft.
⅞-in. oak flooring	3.5 lbs.
⅞-in. spruce flooring	1.9 "
Nailing strips	0.2 "
Wire centering for arches	1.3 "
Ceiling construction	1.1 "
Plaster (in finished ceiling), 4 to 6, average	5.0 "
Concrete, 35 to 45, average	40.0 "
Total weight of finished floor and ceiling (exclusive of iron beams and girders), 47 to 59 average	53.0 lbs.

Certainly the results of this test do not warrant the unqualified advocacy of plaster set forth by Mr. Seeley, nor the condemnation of terra cotta arches. The repairing of this ceiling is the smallest that could be conceived, simply replastering the surface, and consequently much less than having to replace wire lath, etc. The fact that the load has remained on for over two weeks since the fire and was increased by being soaked while throwing water all over it to cool down the brickwork, is a proof of the great strength of the terra cotta arches as well as their resistance to fire and water, and their economy in repairs.

The reason for some of the failure of arches referred to by Mr. Seeley, I believe, will be found in poor construction and materials. In this connection there is much to be said as to the proper design of hollow tile for arch blocks, the inferior quality of material sometimes used, and careless methods of laying.

It will be found a very difficult matter to prove that burnt clay, when properly treated and applied, is not the best fire-resisting material for building work, and I may say that I believe Mr. Constable has approached this new and half-developed art in the right way by a most extensive and elaborate series of tests of materials so as to know precisely their intrinsic and comparative merits. A close investigation into the question of usual and unusual temperature will enable one to judge of and compare the various tests that have been and are being made, and to form an opinion upon them.

The result of transmission of heat through cement, terra cotta and brick were interesting and I believe show that some of the results feared by Mr. Seeley from expansion are not quite as great as one would infer.

I would also refer to the point Mr. Constable raised in connection with the Bleecker St. fire, which was that a large open space between the ceiling and the floor might be readily converted in many buildings into a reverbatory flue supplying heated air to the room above, thereby intensifying the heat so that no materials could be expected to withstand it. That is a well-known principle in securing intense heat in kiln and heating furnace.

Yours respectfully,

Yours respectfully, James C. Rossi, C. E.

Perth Amboy, N. J., April 29, 1896.

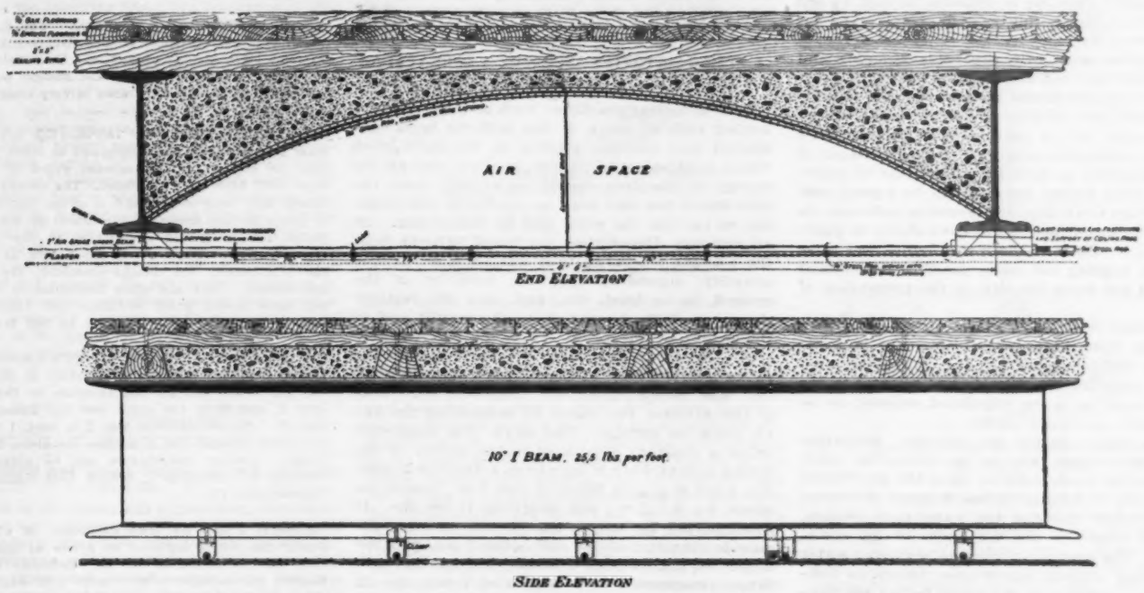


FIG. 1.—METHOD OF SECURING CEILING TO FLOOR BEAMS IN FIREPROOF CONSTRUCTION.

The Specifications for a New Water Supply for Jersey City.

Sir: I am content to leave most of your remaining criticisms of the Jersey City specifications (Eng. News, May 7, 1896) to the judgment of those informed as to the circumstances. I feel confident of the correctness of my position. Your language as to the chemical standard, which you pronounce "improper" and "calculated to render the specification for filtration farcical" is scarcely within the border of professional courtesy in my opinion. Your radical view comes from your failure to note that under the "Right of Eminent Domain" clause the contractor may avail himself of all the city's power to prevent pollution of the stream. As advocates of filtration claim that this pollution can be prevented, if their theory is correct the contractor may reduce and control the amount of nitrates and chlorine to any extent. This was contemplated in the specifications. The position of the city authorities is that this attempt will cause the city a heavy expenditure, with doubtful results, and the advocates of filtration by the city have not taken this and many other expenses into account in comparing the cost of filtration with the cost of a pure gravity supply. The specifications are intended to put exactly the same burden upon the contractor which would rest upon the city if it had power to build filtration works, and to give the city the same guarantees and immunity for further expenditure which it has always insisted upon from the contractor for a gravity supply. This will enable them to determine whether they have or have not been wrong in believing that the alleged economy of filtration is only apparent.

I did not dilate upon this, as I knew I was encroaching upon your space already, and thought the specifications when published would sufficiently explain my claim that your criticism was not justified.

As to time allowed for bids, it is absurd for you to attach criticism therefor to the specifications or look to me for an explanation, nor did I urge anything in justification of the short time allowed as you claim. I merely pointed out that it was not comparable with time needed to prepare plans suitable for competitive bids on construction. I do not believe any bids will be received on such filtration and under such guarantees as the city has decided it wants, even if a year is allowed to prepare them. This is not an argument against the specifications, but against filtration, as applied to this case. Few will be found to undertake as a private enterprise what the city is urged to undertake by a faction. Nor is this any reason why the city should open the doors for all kinds of filtration schemes at the suggestion of every filter company in the market. The city does not want a forfeited bond—it wants pure water. I am ready to maintain my position as to mechanical filtration and other points raised by you, and have no fear but that others will be found to take my view of it after giving the whole situation that matured consideration which it needs.

Yours truly, C. C. Vermeule.

71 Broadway, New York, May 11, 1896.

(The general conclusions to be drawn from this and the former communication from Mr. Vermeule are entirely in accord with the editorial comments in our issue of April 30. We there stated, in effect, that no intelligent bids could be expected under the gravity specifications except from those having plans prepared in advance, and that no bids whatever could be expected under the specifications for filtration. It appears from Mr. Vermeule's letters that those responsible for the specifications never expected anything else than this.

Regarding the chemical standards, or those portions relating to the chlorine and nitrates, which were what we criticised, we do not see that they are justified by the following clause in the speci-

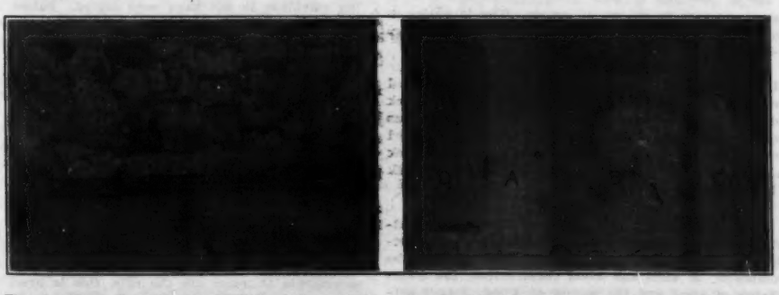


Fig. 1.—View of Ceiling (Under Side of Terra Cotta Floor Arches) at Conclusion of Test.

Fig. 2.—View Showing Effect of Fire on Plastered Walls.

TEST OF FIREPROOFING MATERIALS MADE AT PERTH AMBOY, N. J.

fications, under "Right of Eminent Domain," to which reference is made by Mr. Vermeule above:

> The city will also agree to exercise, on demand of the contractor, all its legal powers to prevent pollution of waters tributary to the proposed works; but all expense attendant upon the prevention of such pollution shall be borne by the contractor.

Imagine the feelings of a contractor who is considering bidding on this work and who reads this clause and the chemical standards. In less than three weeks' time he is gravely invited to not only perfect engineering and financial plans for the construction and operation of 35 acres of covered filter beds, with expensive pumping and conduit systems, but also to investigate the present and probable future pollution of the Passaic River, from both organic matter of vegetable and human origin, and in addition to all this, he must make an exhaustive study of the legal status of stream pollution in New Jersey in order to determine to what extent the city will be legally able (and willing) to aid him in preventing pollution. In reality, the specifications ask contractors to guarantee the condition of the water before and after filtration, holding out as a possible inducement undefined aid from the city in the prevention of pollution.

This alone would be sufficient to deter any sane man from bidding, but the case is made worse by the provision that the contractor must agree to maintain the chlorine and nitrates in the filtered water at some stipulated amount to be expressed in parts per million.

Let us first consider the chlorine. Filtration has no effect upon this, so the contractor must here place his whole reliance upon the prevention of pollution, or he must name a figure in excess of any possible quantity the water may contain, which, of course, is not the intent of the specifications. The amount of chlorine in filtered water is absolutely without significance, except as indicating the condition of the water before purification. All of the organic matter and all the bacteria might be removed by filtration and yet the chlorine would remain unchanged. If the specifications are intended to limit the permissible amount of pollution in the unfiltered water they would have been clearer if both the chlorine and nitrate standards had been applied to the water before instead of after filtration.

Nitrates indicate, when present in large quantities, that a considerable amount of organic matter, of either animal or vegetable origin, was once present in the water and has been transformed from unstable forms of nitrogen to a stable compound with some mineral base. Given a certain amount of organic pollution in an unfiltered water and the efficiency of filtration would be gaged, in part, by the increase in nitrates. In so far as a contractor relied upon the prevention of pollution to maintain his standard of purity he would guarantee low nitrates, since the exclusion of organic matter would mean less work of nitrification for the filters to perform and therefore lower nitrates in the filtered water. Let us suppose that he established a low nitrate standard, expecting to prevent the pollution of the river. If for any reason these expectations are not fulfilled and the river water becomes badly polluted, he would, under any other specifications, look to his filters to effect the desired purification. This they would do, if properly designed and operated, but in doing it the nitrates, already above the guaranteed standard, would be increased. If, on the other hand, the chief, or indeed the whole reliance, were placed on filtration, and the nitrate standard were placed high, this might mean that high chlorines were to be expected, which could not be brought down to the chlorine standard, since chlorine is not effected by filtration.

We are, therefore, brought back to the starting point, the specifications for filtration are impracticable, however viewed. Mr. Vermeule himself says that he expects no bids under them. If an engineer draws specifications under which he admits no bids can be expected, and if the specifications lay down standards impossible of fulfillment, should he object to having them characterized as "improper" and "farcical" and urge breach of "professional courtesy" because they are so characterized? Has an engineer a right, professionally speaking, to formulate specifications under which no one can bid? Is it an excuse for such action that his employers wish to prove that their critics are wrong in suggesting methods at variance with their own plans?

If local conditions are such that filtration is impracticable or undesirable why not say so, or after saying so, as Mr. Vermeule did, why not refuse to draw up specifications which can only lead the ignorant to believe that a real attempt is being made to secure bids for filtration and serve to annoy others, including any contractors who might take them in good faith?—Ed.)

A SPRING-SUPPORTED ANVIL FOR A DROP-TESTING MACHINE.

In drop-testing machines, such as those used for testing railway axles, it has hitherto been considered that absolute rigidity of the anvil block was a most essential feature, in order that all the energy of the drop should be exerted upon the axle under test and none be wasted in compressing or moving the anvil and its foundation. In all ordinary drop-testing machines hitherto built the amount of energy thus wasted is a variable quantity, depending upon the condition of the ground, as to frost, etc., and upon the relation the mass of the anvil bore to the weight and to the height of the drop. To avoid this variable error, Mr. F. D. Casanave, General Superintendent of Motive Power of the Pennsylvania Railroad Co., has reconstructed the drop-test apparatus at the Altoona, Pa., shops by supporting the anvil block on springs. The anvil thus supported offers a constant resistance to the action of the falling weight when it falls from a uniform height. The anvil is a solid block of cast iron, measuring about $4 \times 5 \times 2$ ft., and weighing 17,500 lbs. It is supported by twelve double-coil springs, the outside diameter of the coil being 8 ins. and the height 9⅛ ins. when open and 5½ ins. when closed. When compressed to a height of 7 ins. the 12 springs will support 80,000 lbs. The axle supports are dovetailed into the block and are placed 3 ft. apart between bearing points. The drop weighs 1,640 lbs., and its maximum height of fall is 43 ft. The axle supports are grooved to receive the axle, and the bottom of the groove, in line with the axis of the axle, is curved convex toward the axle to a radius of 5 ins., so that the axle lies on rounded bearing points. The bottom of the drop weight is also rounded to a radius of 5 ins., so that it touches the axle only at the middle point. The resistance of the anvil is made up chiefly of the inertia of the mass of iron, weighing 17,500 lbs., and the slight movement that takes place is against the resistance of the springs, which is a constant quantity for a given movement. The improved drop offers an opportunity for a comparison of tests made at different times and places, which comparison cannot be satisfactorily made at present on account of the variable condition of the foundations.

SMALL PIPE SANITARY SEWERS are recommended for use in portions of New York city by Mr. Horace Loomis, engineer in charge of sewers. The localities in question are liable to back-flooding in the sewers at times of heavy rains.

SILVER MINING IN INDIANA is being commenced about ten miles southwest of Richmond, in the Lick Creek hills. In September, 1894, a horizontal shaft was driven into the hill, and then test holes were drilled from the summit of the hill, striking silver-bearing rock at a depth of 200 ft. An 8-ft. shaft is now being sunk and has reached a depth of 175 ft.

A NEW ELECTRIC LIGHT-SHIP, known as light-ship No. 67, is now being built at Steffen's yards in Portland, Ore., for the station at Umatilla reef. It is to be of composite, or steel and wood construction, the framing being of steel and the casing of wood, copper-bottomed. To prevent galvanic action in the hull, it is constructed as follows: First, an inner planking 4 ins. thick is fastened to the steel hull by galvanized bolts and washers. These bolts are sunk into the 4-in. planking and plugged over. A layer of felt will then be put on top of the 4-in. planking, and outside of this there will be another layer of oak planking 1½ ins. in thickness, this latter being fastened to the inside planking by composition nails. This oak planking is then sheathed with copper plates. The dimensions of the vessel are: length, 112 ft.; beam, 28½ ft.; draft, 13 ft. It will be fitted with a propeller engine capable of giving a speed of nine miles per hour. This will be used in the case of storms to relieve the strain on the anchor chains by going ahead slowly, and also to propel the vessel in case a storm should ever make it necessary to raise the anchor and leave the station. The ship will have an electric light plant with all the machinery in duplicate for furnishing four 1,000-c. p. arc lights at the top of each of the two masts at a height of 54 ft. from the deck. There will also be provided a fog signal, consisting of a 12-in. whistle of the chime class, giving the first, third and fifth notes of the scale. The whistle will be blown either by steam or by compressed air.

THE BATTLE SHIP "OREGON" was docked in the stone dry dock at Mare Island, Cal., on April 26. An extreme high tide was chosen, and the vessel was worked in without mishap, although the margin both in width and depth at the dock entrance is very small.

THE FIELD TESTS OF IMPROVED RIFLES by the state board of examiners appointed to select an improved arm for the use of the national guard of the state of New York have been completed. The results of the tests which were very severe and of great variety, has been to place in the hands of the board at least five guns which are a decided acquisition to the military resources of the nation. They are known as the Savage, the Winchester, the Briggs-Kneeland, the Blake and the Burton. They are quite dissimilar in construction, but have shown great precision and rapidity in fire, ease of handling and resistance to bad treatment.

A COMMERCIAL TOUR TO SOUTH AMERICA is being arranged by the National Association of Manufacturers. The party will sail for Southampton on the "St. Paul" July 1, and from the same port for Buenos Ayres on July 11. The period from Aug. 2 to Sept. 1 will be spent in a tour through the Argentine Republic, Uruguay and Brazil. Further information can be obtained by addressing Mr. Theodore C. Search, 1748 North Fourth St., Philadelphia, Pa.

A NEW FORM OF GAS BURNER, in which the ordinary fine slit is replaced by a row of small holes, is said, on the authority of Mr. Leicester Greville, an English gas chemist, to give more than double the light of the ordinary burner, with a consumption of 3.1 cu. ft. per hour.

ELECTRIC LOCKING OF RAILWAY SIGNALS.*

By V. Spicer, Union Switch & Signal Co.

It is confidently assumed that the track circuit is familiar to all. The history of its invention by Mr. Robinson, in 1872, and of its experimental and practical application to signaling in its various forms on railways for the past 20 years, is interesting, and has been extensively written up and discussed. Its application in connection with electrical locking of the levers of an interlocking machine, although more or less practiced in past years, has not been sufficiently general to have become equally familiar.

It is intended to treat here of some historical facts and a personal experience with electric locking of levers of various forms of interlocking apparatus. The first interlocking machine erected in this country was imported from Saxby & Farmer, of England, and put in operation on the New York division of the Pennsylvania R. R., near Newark, N. J., in 1874. (Illustrated and described in Engineering News, March 1, 1894.) This machine is now in the collection of railway relics at the Columbian Museum in Chicago. It is the type from which most of the interlocking machines in use have been copied. Before touching on the manner in which electric locking of levers has been done in the past and the reasons why such locking has been considered advisable, it may not be amiss to look over the arrangement of mechanical locking of such a machine. The locking is designed and applied to an interlocking machine for the purpose of regulating the order in which levers shall be operated in such a manner that those attached for the movement of switches, locks and signals of routes shall require those for the movements of similar functions in conflicting routes to be locked against being cleared. That is, in order to set the switches for a route, lock them and clear the signals for the passage of a train, all opposite or conflicting routes must first be blocked. This is all that can be provided for with the mechanical locking, and under well disciplined levermen, where slow movements of trains are the rule, this is practically all that can be required, and admit of expeditious handling of the traffic. Detector bars prevent the throwing of locks and switches under moving trains, and levermen are depended on to use proper care in the manipulations. Where high speed of trains are indulged in, however, although the same precautions in locking and handling are observed, a like amount of dependence on levermen cannot safely be placed, and practice has shown it to be absolutely necessary, to prevent careless or premeditated changes in routes once given for such movements. The probable meeting of trains at a junction or a crossing, or running

*A paper read before the Railway Signaling Club, Chicago, May 12, 1896.

into an open drawbridge, provided with carefully handled interlocking apparatus, is remote. The possibility exists, however, since there is no physical check on levermen to prevent them from clearing the route and during the passage of the train, and before it has arrived on the switches, reversing these and clearing the route for a conflicting movement, causing a derailment or a collision and consequent wreck, not only to the train but to the apparatus. The distant signal at "clear," under these conditions, becomes a very dangerous thing, as it invites high speeds and increases the disastrous effects of a derailment or collision.

It was pretty clearly seen in the early days of interlocking in this country, that means for preventing these dangers were necessary. These were sought by the exploiters. The Jackson Switch & Signal Co., of Harrisburg, Pa., had secured the Saxby & Farmer and Toucey & Buchanan patents for interlocking machines. They had erected several plants in 1879-80 and the repeated accidents caused by levermen reversing routes before trains had cleared the interlocked region, set them to thinking how to prevent them. Electricity was suggested and Mr. Jackson devised and patented a scheme for attaching an electro-magnet to operate a latch arranged to lock the signal levers in their clear positions by means of the train in the section. In 1872, Wm. Robinson invented and patented the rail circuit, illustrated in Fig. 1, and in company with Oscar Gassett, Israel Fisher and others, developed a system of block signaling, employing this as the means for operating signals, locks on switchstands, highway crossing gates, alarm bells and annunciators. It took several years to demonstrate the

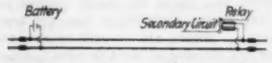


Fig. 1.—Original Rail Circuit Devised by Wm. Robinson in 1872.

practicability of the system and a great many devices for the purpose were experimented with before it was perfected. Tracks in those days were not what they are to-day and difficulties existed which have since been largely eliminated. These men labored against great odds and spent much money and thought developing the first steps in an art which we, to-day, may learn in a few minutes. They devised and patented a lot of circuits, instruments, etc., for signals, locks on switch stands, drawbridges, gates, etc., anticipating by several years what has only recently been considered seriously as being necessary. The same ground has been gone over by others, in recent years, in most instances without a knowledge of what had already been done and many similar devices have been produced.

The earliest applications of the track circuit were made on the Fitchburg R. R. in Boston and its use in electrically locking switchstands and drawbridge mechanism practically was first made on this and the Boston & Maine roads in 1878-79. Gassett equipped a number of switch stands with electric locks in the block signaled region, at Waltham, Mass., on the Fitchburg road. These were applied to the stands and so arranged, by using a second-

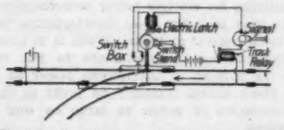


Fig. 2.—Electric Locking as Applied to Switch Stands by Oscar Gassett in 1878-79.

ary circuit, operated by the track relay in the section, as to lock the stand against being opened to throw the switch while a train was approaching in the block, as shown in Fig. 2. Provision was made for unlocking the stand when it was necessary to operate into and out of the siding. The act of moving the switch from the line, opened the circuit by means of a shunt actuated by the points of the switch, causing the signal to show danger. Similar devices were applied on the Old Colony, Boston & Maine and Eastern railways, on drawbridges as well. It may be of interest here to state that the overlap system was introduced at this time on the B. & M. block signaling between Salem and Beverly.

In 1878 the Union Electric Signal Co. was organized in Boston with Gassett as superintendent and electrician, and the devices he and others had invented as stock in trade. Jackson in his search for a means for electrically locking levers, came in contact with Gassett and soon after a consolidation of interests was brought about. It is not assumed here that this was the direct result of the meeting, but it occurred soon after. Gassett had devised a scheme for locking the levers of an interlocking machine, by means of electric latches operated both by the track instruments and track circuit. Jackson's device for the same purpose shown in Fig. 3 anticipated the use of the track circuit. One of Gassett's devices provided for locking the signals as soon as a train had entered under a clear distant signal, as shown in Fig. 4. By means of a track instrument, or "treadle" T located near the distant signal, the wheels of the engine caused the circuit on the electric locking latch A on the signal lever to drop. This was held there and prevented from releasing by a second electric latch B which would release when the train had passed over and out of the interlocked region, striking a second track instrument R provided for the purpose. These ideas were identical in their purpose, which was to secure the route once given for the passage of a train over a certain point by electrically locking the signal levers in their positions for such passage and releasing them after it had been made. Later on Jackson took out a patent on a more extended use of his electric latch, which was to lock the levers of opposing routes in their normal or danger positions, instead of those of the route desired in their safety posi-

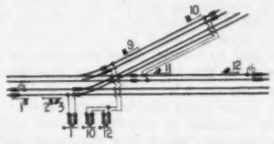


Fig. 3.—Jackson's Electric Locking Operated Both by Track Instruments and Track Circuit.

tions. In his application for a patent he showed the following conlitions of tracks at a junction. Supposing a train, Fig. 5, on track A to take the branch track D. The locks were applied on the levers operating the signals on track C holding them in the danger position to prevent clearing for a train on that track. Similarly, a train entering on track C would lock levers operating signals for track A to D and also levers operating signals for track B. This electric locking was to be actuated by the track circuit, extending from the vicinity of the distant signal to the crossing frogs. The circuit from each section of track was carried direct to the magnets of the electric latches and did not provide for the use of a relay. We know now that this is not practical. Experience has demonstrated the impracticability of operating high resistance magnets and the necessary batteries directly through the tracks as part of the circuit, and, con-

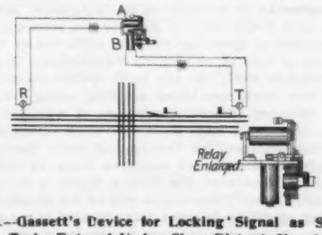


Fig. 4.—Gassett's Device for Locking Signal as Soon as Train Entered Under Clear Distant Signal.

sidering the fact that the ordinary interlocking accomplishes exactly what this scheme was designed to cover, the only feature of interest in the device seems to be that it involved the electric locking of levers.

The electric locking of levers of manual, hydraulic and pneumatic interlocking machines was put into practical operation at various places during the years 1882-3-4-5 by the Union Switch & Signal Co., employing the track circuit for the purpose. The first application was made to the Saxby & Farmer machine in 1882 on the Pennsylvania R. R., and provided for locking signal levers at safety by the train entering under the distant signal so set, as shown in Fig. 3. It soon became evident that this was

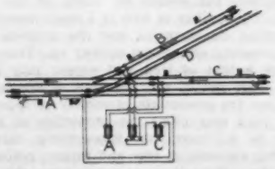


Fig 5.—Jackson's Device for Locking Levers of Opposing Routes in Their Normal or Danger Positions.

not the proper principle, as it prevented the signals from being restored to danger until the train had passed beyond the interlocked point. This was changed, and an arrangement made that provided for locking the lock levers of switches, thus allowing the signal levers to be restored to the normal position as soon as the train had passed the signals, but secured the lock levers until the train had gone beyond the limits of the interlocking on single track lines and beyond the crossing frogs on double track lines. The expense of bond wiring and insulating the rails for such long distances led to a change in these arrangements, and the locking was made to take place on pulling the distant signals to clear. This was accomplished as shown in Fig. 6, by having a circuit breaker operated by the blade itself on being pulled to clear, which opened the circuit of the electric latches on the lock levers by means of an interlocking relay in the tower. The signal could be restored to the danger position, but the train movement over the plant was necessary before the latch could be released. Here the tracks inside of the home signals are included in one common section supplied with a track battery and relay. The circuit controller on the distant signal on being opened by the blade at clear, causes the magnet A of the locking relay to discharge, which in turn opens the circuit on the electric locks. The interlocking arrangement of the relay prevents closing this circuit again, until the magnet B has been discharged and again charged. The track relay C becomes discharged when the train enters the common track section and opens the circuit on B, holding it open until the train has passed off the common section. As soon as B's circuit is opened, A's armature bar is released and

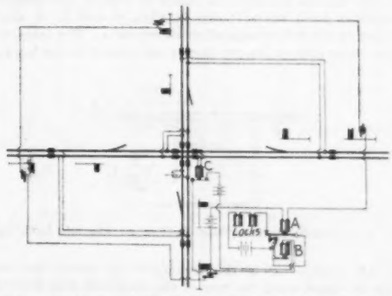


Fig. 6.—Electric Locking Device Actuated by Pulling Distant Signal to Clear.

returns to its normal position, closing its part of the lock circuit. But this circuit is looped through B's armature and requires B to close before the circuit can be completed. As long as the train remains in the section this cannot take place, by the reason of relay C being open. On passing off the common section C again recovers its current, and thus closes B's circuit restoring the electric latches and releasing the levers.

Fig. 7 shows another arrangement where circuit breakers are operated by the levers in the tower instead of on the distant signals. Theoretically, this was good, but in practice it involved much trouble. Levermen, by order, are required to try their levers from time to time, during bad weather, to see if they are in working order, and the signal lamps lighted. This, of course, resulted in locking up the machines electrically, and the attachment became a positive nuisance. Cases were reported where trains had fouled at crossings where the electric locking should have prevented such occurrences, and inspectors discovered that the levermen had secretly rigged circuits so that the electric locks were cut out entirely. This led to the introduction of "release buttons," which allowed the operators to try their signals and then release the electric latches. The convenient proximity of the buttons detracted from the usefulness of the electric locking, as levermen could release the locks at any time and through carelessness or design, cause serious harm by reversing a

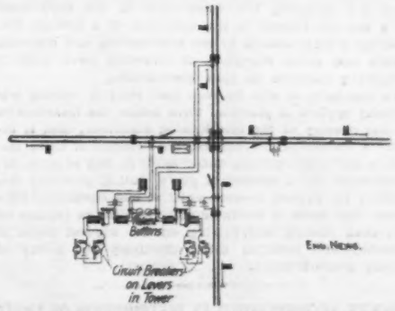


Fig. 7.—Electric Locking Device Operated by Levers in Tower.

route after giving it to a train. The releasing buttons were then put down stairs, or at a remote distance from the operating floor, but the crafty leverman soon found means for short-circuiting at a convenient point and several instances were discovered where "jump wires" had been put in and cleverly concealed, leading to some convenient point on the operating floor. This threw all precautions that had been taken to prevent unlocking at will quite out of countenance. Expensive and complicated "time movements" and various apparatus for checking the levermen and recording the times that they manipulated the electric locking were devised and put in service, which only resulted in complicating matters.

In those days, interlocking was looked on by the average railway employee as a downright imposition, and it was

practically impossible to have proper attention given to the tracks to maintain them in order so that insulations, bond wires, etc., could be kept in proper form to insure keeping the track circuit in working order. The greatest sort of trouble resulted with the electric locking, as, by failure of the track circuit, the locks would drop and the apparatus be locked up indefinitely, or until they were broken into and released by "plugging." The maintenance of batteries was put in the hands of telegraph repairmen and received care and attention only when they had run completely down or when these men had time or inclination to attend to them.

The electric locking of levers has always been a feature of the electro-pneumatic interlocking apparatus, where it has been put to a more extended use, being made to do the service of detector bars. The levers for operating switches and their locks are thus secured during the passage or presence of trains on the track of the route cleared. The circuits for the purpose, as shown in Fig. 8, are changed somewhat from those shown in Figs. 6 and 7. A short section of track is insulated as shown at A. The train entering here causes the opening of the circuit on the latches

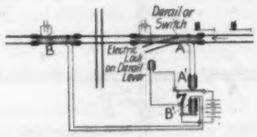


Fig. 8.—Electric Detector Bar System of Electric Locking.

through magnet A^1 of the locking relay which can not again be closed until the rear of the train has gone beyond a similar section B, actuating the other magnet B^1 of the relay. Each switch in the plant is similarly equipped with an insulated section and the action on the electric latch prevents operation of the lever the same as a detector bar would do. This arrangement is known as the "electric detector bar" and has been in service at several plants for years. The expense of maintaining the insulated sections in tracks acted against this scheme in most cases and mechanical detector bars were applied as being cheaper to maintain.

The safe and practical use of the manual block signaling system is attained only by the electric locking of levers in the normal or danger position by means of the track circuit. Supplemented by the electric slot on the signal, which is itself governed by track circuit, the manually operated block signal is practically a perfect system for the safe spacing and blocking of trains, under absolute blocking rules. Such a system has been in service on a number of eastern trunk lines for many years.

Up to November, 1885, there were 3,165 working levers in use in 227 plants divided among thirty-five different railways in this country. Seventy of these plants had electrically locked levers. Since then, aside from the pneumatic plants installed, there have been few instances (not over a dozen) where electric locking of levers was applied. There is no doubt that the lack of proper care in the maintenance of the electric apparatus and the consequent failures in the locking was the direct cause of its general abandonment. We were then many years in advance of the times, and it is only now, since the "Signal Engineer" has been recognized, and railway managers are realizing the importance of his department as a distinct branch in the operation of a system, that intelligent maintenance of the interlocking and signaling plants and strict discipline of levermen have made it practically possible to lock electrically.

To conclude, it will be seen that electric locking was actually applied in practical form before the introduction in this country of the interlocking machines; that it became a feature of the earliest installations of these machines and continued so, under more or less adverse circumstances, for a number of years, falling generally into disfavor for evident reasons until at last conditions have arisen that make it desirable and practical to resume its use, thus placing interlocking on the highest plane of efficiency and insuring more effectively the safety of railway transportation."

RESULTS ACCOMPLISHED IN DISTRIBUTION OF LIGHT AND POWER BY ALTERNATING CURRENTS.

By W. L. R. Emmet.

The introduction of successful polyphase motors has constituted a very radical and important step in the development of the electrical art. The number of persons who realize the importance of this step is as yet small, and, like other new things, it cannot attain great successes until its merits and possibilities become more or less familiar to the public and to the practical business men on whom the responsibilities for new developments must largely rest.

In the past, the use of alternating currents has been almost exclusively for incandescent lighting, and this narrow limitation has crippled the development of the art. While the applications of direct currents have called forth very large investments in plants and distributing systems, the uses of the alternating current have, as a rule, been on a much smaller scale, and the methods used have been developed rather with a view to reduction in first cost, than to the attainment of the most economical results in operation.

The reasons for this somewhat half-hearted development may be stated as follows:

1. The average efficiencies attained in most alternating plants have been very low.

2. The distribution of potential obtainable with the ordinary methods has been imperfect.

3. No reliable alternating arc lamps have been available.

4. No practical form of single-phase alternating current motor has, up to the present time, been introduced.

At no time have all these difficulties been entirely unavoidable in alternating current distribution; they have, however, been fixed features of the system as it has in the past been installed by our manufacturing companies and used by electric light companies in this country; the state of the art being such that improvements were beyond the reach of most central station managers.

In recent years great developments have been in progress in the branches of electrical science pertaining to alternating currents; much new apparatus has been developed, plants have been installed on new lines, and practical results are to-day being accomplished that show that it is possible to overcome all of the objections which have been mentioned. We will briefly review in order some of the means by which the difficulties mentioned have been and can be avoided.

Efficiency.—The greatest losses in the average alternating plant are due to the waste in iron cores of transformers, which goes on whether the transformers are loaded or not. This waste can be reduced, either by the use of transformers of high light load efficiency, or by arrangements for cutting out transformers at light load. Where primary distribution is used with large numbers of independent transformers, the extent to which these remedies can be adopted is very limited, since reduction of core loss can be obtained only at the expense either of regulation or of first cost. If, however, secondary distribution is used, that is, low-tension mains with transformer sub-stations, it is often possible to arrange means of cutting out transformers at times of light loads. Furthermore, on such systems, very accurate regulation in transformers is a matter of no importance, since all transformers divide the load more or less evenly between them, instead of operating from the same line at various conditions of load as in primary distribution. Thus, for this secondary work, we can build special transformers having very small core losses and thus obtain very high all-day efficiency without impairment of regulation.

I have in mind a large plant now being equipped with alternating apparatus for lighting and power distribution on thoroughly modern and improved lines. In this case a system of three-wire, low-tension mains is to be laid over a large area. These mains will be fed at street corners from specially designed transformers in ventilated manholes. These transformers are to be of 100 K-W. each, and are to have a core loss of only 500 watts, or one-half of one per cent of the capacity. The efficiency of these transformers at one-quarter load will be higher than at full load, the principal loss being in the copper. Thus a transformer may be made to fill the same functions as a direct-current feeder. If we are willing to introduce some drop between generator and main, we can get high light load efficiency with moderate cost, and we shall retain the important advantage that transmission is possible over long distances, with small losses, through the use of high voltage.

In no branch of electrical work has the improvement of recent years been more marked than in the manufacture of transformers. This improvement has not been brought about by any radical discovery as to the principles involved, but simply by study of the economic conditions. The quality of iron is a most important matter in building transformers, and the methods of handling and annealing are almost equally so. Then, the proportions by weight of iron and copper may be varied through a wide range, and the plan of arrangement of coils and iron are susceptible of endless variation. Every change of plan may effect the properties of the transformer as to self-induction, magnetizing current, hysteresis, eddy currents in core and copper, resistance loss and regulation. Thus there is much room for judgment in the design or purchase of transformers. At the price for which transformers can be bought it is folly to use bad ones. Thousands of transformers are in use to-day that are fit for nothing but a scrap pile, and many are now being manufactured and sold that are no better.

Regulation.—The cause of bad regulation in most existing alternating plants is that each individual installation is connected to a separate transformer, and that in these transformers, and the wiring connected to them, there are losses varying with the load, which, of course, can not be controlled from the station. Since regulation is a matter of most vital importance, we must see that with primary distribution good regulation is imperative. To make transformers of specially good regulation, something must be sacrificed, either in economy of first cost, or in light load efficiency, or in both. Thus there is always an appreciable drop through resistance of wire in transformers, and this, combined with the drop in primary and secondary wiring, gives rise to serious variations in pressure on lights at different points.

Another fruitful source of potential variations on alternating circuits is found in the self-induction of circuits and also in the self-induction of transformers. The electro-motive forces introduced by self-induction being out of phase with the current, are variable in their effect, and give rise to troubles that sometimes seem erratic, although in reality they are governed by well defined laws, which, if properly observed, enable us to obtain accurate results.

Motors.—Until very recently the operation of motors from alternating systems has been practically out of the question, since no suitable motor has been obtainable. Thus alternating apparatus has been available only for lighting, while in direct-current stations motor load during the day has been a most important source of profit. It may be mentioned here that while incandescent lighting is at the present time meeting sharp competition from other forms of illumination, the electric motor is growing very rapidly in popularity. It has taken the public a long time to gain confidence in electric power and to realize its usefulness. It is only within very recent years that large manufacturers have begun to use electrical power distribution to any great extent. At present, the work is being carried on very actively, and highly successful and economical results are being obtained in many large mills. As a means of power distribution, even for short distances, electricity has no rival; while for lighting, its advantages, though great, are relatively much less positive.

Although for many years efficient electric motors have been in general use, there are many central stations in whose business power distribution has not been a very important factor. There are several causes which have tended to restrict the use of electric power, among which we may mention the following:

Voltages that have been available for direct-current work have not admitted of transmission to considerable distances.

Motors have required a certain amount of attention, which users were sometimes unwilling to bestow.

In certain classes of manufacture, the sparking of motors has been a source of danger.

The most important cause, however, has been that, as a rule, the same apparatus has not been available for the operation of lights and motors; consequently, central stations have not been in a position to make attractive propositions to large users of power.

The introduction of good alternating-current motors has opened a new era in electric power distribution, and seems to promise a great extension of its uses. With these motors the difficulties of distance are practically eliminated, since there is virtually no limit to the voltage which can be used. The mechanical features of the motor are near perfection, since it requires no care save what must be bestowed on its self-oiling bearings. These motors can be so arranged that they can be operated with perfect safety in any part of a powder mill, or oil refinery, and, in fact, a number of them are being operated now in highly explosive atmospheres, where a spark would work destruction.

With facilities for electric power transmission thus improved, we may look for great developments in the sale of power from central stations. When it is profitable for large manufacturing establishments to put in electric plants for the purpose of distributing power on their own premises, there should certainly be profit in the sale by electric companies of power to large as well as small manufacturers.

The actual saving in fuel effected in the operation of a large mill by electricity for power distribution is ordinarily very large; often as much as 50%. With good equipment, this is, however, only a small part of the saving effected by electrical distribution. The cost of coal seldom amounts to more than half the expense incident to the production of power, and in most cases it is a much smaller proportion of the total. If power is obtained from a central station, the coal is bought cheaper and used more economically, while the other items of expense will in many cases be almost a clear saving.

The introduction on any large scale of electrical power distribution, of course, requires the investment of a good deal of money in motors and alterations of plant. Power users are often slow to make these investments, because they are not familiar with electrical apparatus and do not realize the advantages to be gained. Repeated investigations have proved that users almost always far underestimate the cost of power.

The different methods of distributing power and light by alternating currents can best be illustrated by diagrams showing the connections used with each. We will briefly review some of the applications of the systems now in general use.

Fig. 1 shows the three-phase system as ordinarily applied to the transmission of power for lighting and other purposes over long distances. The generator may be of any convenient voltage, since step-up transformers are used. These transformers are in three units, or groups, any two of these units being available to transmit a large proportion of the power in case one is disabled. Two sets

of step-down transformers are shown, one supplying 1,000-volt distributing lines, and the other supplying a system of four-wire secondary mains. With a given lamp voltage, such mains give a slightly better copper economy than the ordinary three-wire system ,and afford an excellent means of secondary distribution.

Such a system as is illustrated in this figure, will give excellent service in almost any town, the low-tension mains taking care of the thickly built up portion and carrying the bulk of the lighting load, while the high tension distributing system covers all outlying portions and operates large power units. A number of large plants

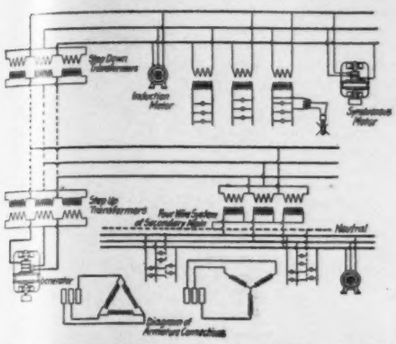


Fig. 1.—Diagram Showing the Three-Phase System as Applied to Long Distance Transmission of Electric Current for Lighting and Other Purposes.

have been installed within the last two years, using the three-phase system, as here shown.

Fig. 2 shows the connections for distribution by the monocyclic system. Here all lights are connected single-phase between a single pair of conductors leading from the generator, the motors being operated from the same single-phase circuit in combination with a third conductor leading from what is known as the "teazer coil" on the generator. Here the simple three-wire system is used for secondary distribution, and if it is desired to connect motors to the low-tension mains, a supplementary transformer is used, which supplies a secondary teazer wire; to this and the outside wires of the three-wire system the motors are connected. The great merits of the monocyclic system are that the number of conductors required for lighting and power distribution is reduced to a minimum, and that no unbalancing is possible. The operation of three-phase motors from this system is in all practical respects the same as when they are run from three-phase circuits.

Fig. 3 shows the connections of the two-phase system, with distribution by four conductors. Here the lighting is divided between two separate circuits, which must be kept balanced within certain limits, depending upon the regulation of the generator, or the amount of care that can be given to the adjustment of pressure on the different sides. Where motors are run, the two circuits must be brought together. There is no economical and convenient way of operating secondary distribution from this

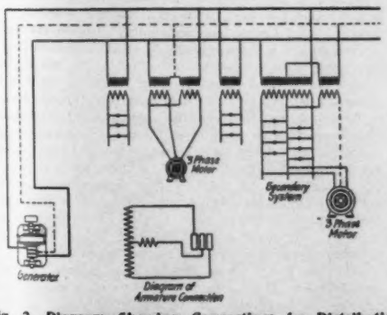


Fig. 2.—Diagram Showing Connections for Distribution of Current for Light and Power by Monocyclic System.

system. Two independent three-wire systems could be operated, but these must be brought together when motors are to run. The complication of balancing such a system would be prohibitory. The two-phase, four-wire system can be operated either from a generator with two independent circuits, or all four conductors can lead from one armature winding.

Fig. 4 shows a method of single-phase lighting distribution from a two-phase dynamo. Here the two single-phase leads are taken out at points 180° apart on a progressive armature winding. At points 90° from those leads two other leads are brought out; each of the latter can be used with the pair of single-phase leads to run one-half the capacity of the machine in two-phase motors. These two power loads can not, however, be brought together.

The greatest disadvantage of this system is that, when carrying a single-phase load, a large proportion of the armature conductors are ineffective, and simply introduce useless resistance and self-induction in the circuit. Thus with the same loss the generator will deliver 42% more power as a quarter-phase machine than it will as a single-phase machine.

Fig. 5 illustrates the two-phase, three-wire system, which has been used to some extent both for high-tension distribution and for distribution by secondary mains. The principal advantage in this system is that it requires one less conductor than the four-wire, two-phase system. Its disadvantages are that the insulation of the apparatus is subjected to a voltage 42% higher than that which is available in transmission, and that the self-induction in the lines and transformers causes an unbalancing of the voltages on the two sides of the system, accompanied by the distortion of the phase variation. The extent of this unbalancing depends upon existing conditions, and is very different in different cases.

In addition to the systems above described for distributing power by induction motors, we have other means of power distribution by alternating currents. The synchronous motor, for certain classes of work, is highly efficient and reliable, and is extensively used, although it will not fill all the requirements of general power distribution.

The rotary converter also fills a very important place in the engineering work of the day. A synchronous motor is simply an alternating dynamo whose functions are reversed. They may be used either on single-phase or polyphase circuits. In its simple form, a synchronous motor has no power of starting itself on a single-phase circuit. On a polyphase circuit it starts with more or less torque as an induction motor, and will come to synchronism. As a rule, however, the starting of synchronous motors is not vigorous, and is accomplished by a large draught of current; hence their applications are limited. A rotary converter is a synchronous motor of suitable construction, whose armature windings, besides being

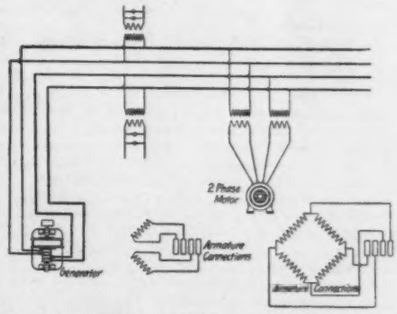


Fig. 3.—Diagram of Connections for Distribution by Four Conductors, Two-Phase System.

connected to collector rings, are also connected to a commutator. As the machine revolves at synchronous speed, brushes collect direct current from the commutator, this current being partly rectified and partly generated by the machine. This machine deals in direct and alternating currents and mechanical power; supply it with any one of the three, it will deliver either or both of the others. It is most efficient when filling its functions as a converter from alternating to direct currents. Its capacity is then greater and its efficiency higher than when it runs as a generator or as a motor. To illustrate the use of the rotary converter, I will describe an application now under consideration. The company in question is operating three stations; one of these is very large and centrally situated, with condensing water and every facility for the cheap generation of current. Each of the other stations is about two miles from the main station; both work non-condensing. One of these stations delivers current only on the direct-current, three-wire system, while the other, in addition to similar work, carries a considerable arc light load. In this case the following plan is considered: At the two smaller stations rotary converters would be installed, and would deliver only direct current in one case, while in the other they would also act as motors to operate arc machines through a countershaft, to which they would be belted with clutch pulleys. Suitable step-down transformers would connect the rotary converters to a high-tension line leading to the main station. At the same station three-phase generators of large capacity would be installed. These generators would be designed to deliver both three-phase alternating currents to step-up transformers, and also direct currents at about 250 volts to the outside conductors of the three-wire system. They would be directly coupled to engines. These machines would deliver current simultaneously, in any proportion, to the direct-current, three-wire system, to the rotary converter, or to lines distributing three-phase power.

It is proposed to operate these machines at a frequency of 25 cycles per second, this being well adapted to the direct-current work and also to three-phase power distribution. In this plant an entirely independent control of direct-current pressure within a wide range would be necessary at the main and sub-stations. This would be affected without the introduction of idle currents, by the use of a novel form of three-phase induction regulator connected to the alternating leads of each rotary converter. These regulators would give a wide range of adjustment without any moving connections, and would greatly simplify the operation of the plant, and also increase its economy, since the losses introduced by the regulators themselves are very small, and since conditions of general economy are always maintained.

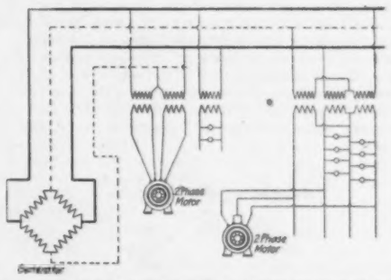


Fig. 4.—Method of Connections for Single-Phase Lighting, Distribution from a Two-Phase Dynamo.

Thus a single engine could carry the whole load of the city at certain times.

Another interesting illustration of a combination of alternating and direct currents is found in a case now under consideration. A company controls about 3,000 HP. in water at a distance of eleven miles from a large town. It is proposed to install three-phase, 60-cycle generators in 600 K-W. units. The current from these generators will be transformed to 10,000 volts and carried over three wires to a city sub-station centrally placed. Here large step-down transformers will be installed, delivering current to 2,000-volt lines, which extend all over the city and carry motors and lights in outlying parts.

In the same station two large Corliss engines are now in operation, and are belted to clutch pulleys on a countershaft, which operates some arc machines and other load. To this same countershaft it is proposed to couple with a clutch a large synchronous motor which will be connected to the 2,000-volt lines. When the water supply is ample, the engines will be shut down and the motor will run the shaft. When the water is low, or more power is required, the engines will be run and the synchronous motor will then act as a generator, running in parallel with the transmission generator. In the central part of the town it is proposed to install a system of three-wire mains and a large storage battery. This battery would be installed in a second sub-station conveniently placed. It would be charged from a pair of direct-current machines, directly coupled to a synchronous motor operating from the 2,000-volt lines. The direct current machines would be used in connection with the batteries for supplying the three-wire system. The plan here outlined has many very positive advantages.

The pressure on the 2,000-volt system can, within certain limits, be controlled at the sub-station by adjustments of the field of the synchronous motor. With telephone communication to the power house, the control will be perfectly easy. The peak of the lighting load being borne by the battery, the generators can be loaded nearly to their full capacity with motors during the day. At night they will charge batteries, using water which would otherwise run to waste.

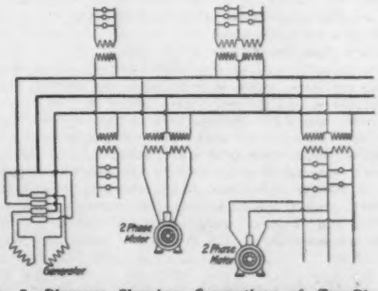


Fig. 5.—Diagram Showing Connections of Two-Phase, Three-Wire System of Electric Distribution.

In both the plants described, the cost of labor would be very small, one man being enough to operate each of the sub-stations mentioned. The saving of labor in operation should be kept constantly in view in all engineering plans. Some of the greatest advantages in modern apparatus lie in its adaptability for such saving.

An infinite variety of conditions exists in different cities and the question of electrical distribution must be carefully studied in each case, in order that money may be invested to the best advantage. An intimate knowledge, both of the apparatus available and of the commercial conditions, is necessary to an intelligent decision in such cases. It is only through the exercise of intelligence and judgment of a high order that the best results can be obtained.

THE NEW YORK MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The 19th convention of the National Electric Light Association was held in New York city on May 5, 6 and 7. Mr. C. H. Wilmerding, of the Chicago Edison Co., the President of the Association, in his opening address referred to the organization of the association at Chicago, in 1885, and the progress in the electric arts since that time. He stated that about 17 years ago the first central station was established; at present there are 2,500 electric light companies in the United States and about 200 municipal plants. These central stations represent an invested capital of $300,000,000. There are in addition about 7,500 isolated plants which have required the expenditure of $200,000,000 more. There are produced daily for these plants 50,000 to 75,000 incandescent lamps; and they consume annually 200,000,000 carbons. The electric railway, dating back only ten years, is using 11,000 miles of track and operating 25,000 cars with an invested capital of $100,000,000.

These figures afford a striking example of American enterprise, as compared with that of the Old World. Against 900 electric railways in this country there are less than 100 in all Europe and the output of a single electric lighting company in New York is greater than the combined output of all the stations in Paris.

Speaking of fixed standards governing electrical constructions, he said that there is much need for such standards and recommended the establishment of a board for the formation of a system of rules to which manufacturers must adhere.

Mr. W. J. Hammer, chairman of the committee on "Standard Rules for Electrical Construction and Operation," recited the preamble and resolutions adopted by the committee in September, 1895.

The National Electric Light Association had invited a large number of the electrical concerns to join it in the formulation of a standard set of rules; this conference met on March 18 and 19, 1896; various rules relative to American and foreign practice were discussed and a committee of seven was appointed to prepare a final draft for submission to the next meeting of the conference, which adjourned until June 25 and 26, 1896. The report concluded by stating that there is every reason to believe that the formation of the National Conference upon standard electrical rules will result in the adoption of a single standard for electrical construction and operation, to meet the requirements of the electrical, insurance and allied industries. It was recommended that the association be represented in the National Conference by the appointment of an official delegate. Several members objected to this recommendation on the ground that the association would be bound by the action of the conference, the interest of whose members would be in opposition to those of the National Electric Light Association. It was finally decided to send a committee of five to the National Congress.

Notwithstanding the fact that in former conventions there have been many and spirited discussions on the relation of manufacturing and central station companies the committee announced that it had no report to make. Mr. John I. Beggs thought that the relation between the manufacturers and central stations was one of the most important questions before the convention, and considered the recent patent combination between the two great companies a reason for stronger union in the association. He advised that a new committee be appointed and that special attention be paid to this part of the work. Since the report of this committee had always been a dead letter, Judge E. A. Armstrong thought it should be dropped. On motion the committee was discharged.

Mr. Louis A. Ferguson described a test of the cost of producing calcium carbide at the Spray, N. C., works, and discussed the commercial value of acetylene gas as an illuminant; an abstract of his paper is given elsewhere in this issue.

In the evening Mr. Max Osterberg gave a lecture on the "Rontgen Ray." With the usual apparatus he illustrated how the cathode rays are obtained and from these the X-ray by filtering the light through some opaque solid. These rays travel in straight lines, admit of only slight reflection and as yet can not be refracted. For this reason the rays can not be focussed, and a picture made by means of them is a shadow picture and not a photograph, as ordinarily understood; the photograph being always the same size as the object photographed. He referred to the X-ray as a connecting link between the exactness of natural philosophy and the study of human anatomy. In Rontgen-ray photographs the bones are photographed for the reason that the flesh is the more transparent to these rays; the bones are also to a certain extent transparent, and an over-exposure of the negative destroys the picture.

Mr. W. L. R. Emmet read a paper on the "Results Accomplished in Distribution of Light and Power," which is printed entire in this issue. Mr. Dow stated in connection with this paper that series alternating-current lamps are now an established success and give no more trouble than those of the direct current type; that the rectifier had been used for a number of years in England, and that 73% of the HP. of the engine had been delivered in K-W. Mr. Emmet explained that the rectifying of alternating currents is analogous to commutating in ordinary arc machines; the rectifier introducing considerable self-induction into the circuit, and in this way producing idle currents.

In a paper on the "Evolution of Interior Conduits, From the Electrical Standpoint," by Mr. Luther Stieringer, the history of interior wiring was stated as demonstrating the following facts:

1. Indiscriminate wiring with staples is universally condemned.
2. Cleat wiring is admissible in exposed work where the circumstances admit, but not in any concealed work.
3. Wires imbedded in plaster, depending on the insulation only for protection, are condemned.
4. Lead-covered wires are also condemned, except where protected in a conduit.
5. Wires in moldings do not afford mechanical or chemical protection, and are only admissible in surface work.
6. Wires carried in plaster and covered with split or zinc tubes to prevent injury by trowels, are condemned.
7. Glass or porcelain insulators can only be utilized in special cases of exposed work.
8. Paper tubes do not afford absolute mechanical and chemical protection.
9. Insulated tubes covered with a thin coating of brass or other metals, do not afford absolute mechanical and chemical protection, but, in exposed work, they are, to a certain extent, admissible.
10. Woven fabric conduit does not afford absolute chemical and mechanical protection.
11. Heavy insulating covering, integral with the insulation, offers no absolute protection against mechanical and chemical injury, and is analogous to rubber tubing for gas distribution installed throughout a building.
12. Concentric wiring is practiced in England with satisfactory results, but is not in use in the United States. It offers many possibilities in the direction of a solid and fixed system.
13. Paper-lined iron or steel pipes, known as "Iron-Armored Conduit," "Builders' Tube," "Armorite," "Clifton," and plain iron or steel pipe, are the only conduits that can afford absolute security against mechanical and chemical injury and assure permanence.

The use of conduits having a lining of insulation, in order to be consistent, should place only bare copper conductors within them. There is only one insulated iron tube in use, however, in which this practice is carried out and this is for underground purposes. Conduits, when properly devised to protect insulated electric conductors placed within them from mechanical and chemical injury, make such protection absolute and are accepted by all intelligent architects, engineers and constructors as permanent. Such a conduit, to be practicable, must be a pipe or tube of injury-resisting material; as, for instance, iron gas pipe. The cardinal principle covering all conductors is that they must not allow leaks. The insulation on an electrical conductor if possessing the property of resisting injury and deterioration, might be considered sufficient. The reason for a lining in the interior of an iron pipe is either mechanical or electrical; if mechanical it is inexpensive, if electrical it is rather anomalous that in New York there are 100 miles of pipe in the street in which the insulated wires lie in a bare grounded tube, whereas no such construction may be used in a building. Prof. Sylvanus P. Thompson, in reference to house wiring, states: "What is wanted is a mode of running the wires and fixing the switches and other accessories, that they shall not only be electric-tight, but water-tight, gas-tight, air-tight, oil-tight and rat-tight."

Mr. John F. Kelley's paper, "Some Account of the Evolution of the Inductor Alternator," described with drawings the machines of this type from the invention of Knight's machine in 1854 to the present. Mr. Kelley defined the inductor alternator as one in which the electromotive force in the induced coil is the result, not of changes in the space relations between such coil and the flux-producing agency, but of changes in the flux through said coil, brought about by the motion of iron pieces serving as magnetic conductors. When the flux is due to an exciting coil, the foregoing definition requires constancy of the space relations between the exciting and induced coils, and in general this constancy of relationship is mechanically expressed by the entire immobility of both coils. It is, however, possible that the inducing coil should turn on its axis without in any way altering its relationship to the induced, and in some cases this is the construction adopted.

In discussing the paper Dr. Bell stated in regard to sine waves in alternating-current apparatus, that under certain conditions the distorted wave would give better results, and that this could be explained by considering that the average frequency is higher than that of the fundamental on account of the presence of harmonics. But owing to the fact that induction motors are designed for a particular frequency, the presence of harmonics is objectionable and the use of pure sine waves advisable.

The report of the committee on data is printed elsewhere in this issue.

The title of the second evening lecture was "The Light of the Future," by D. McFarland Moore. Mr. Moore's vacuum tubes were a pronounced success and it is difficult for those who have not witnessed his exhibit at the exposition to realize that so much light can be produced with the expenditure of so small an amount of energy. The light emanates from rarefied air with an apparent absence of heat and combustion. Upon this principle developed, Mr. Moore thinks, depends the light of the future. As a device for transforming electrical energy into light the vacuum tube is very efficient; the majority of authorities placing it at about 70% and the incandescent lamp at 2%. Notwithstanding this remarkable efficiency, it has never been commercially possible to illuminate by vacuum tubes because the light could not be made sufficiently intense. Mr. Moore's invention consists mainly in placing the current breaker of the ordinary induction coil in a vacuum. This permits of breaking the current very much more rapidly than has been possible in air, since the arc which always accompanied the breaking in air is avoided. Upon the rapidity of this breaking depends the brightness of the light. This vacuum current breaker also permits of the use of high-pressure currents. The tubes used are from 6 to 10 ft. long, and about 1½ ins. in diameter, and differ from the Geisser tube only in having no metal terminals, contact being made directly with the glass.

Mr. H. L. Rogers read a paper on the "Evolution of the Arc Lamp." The credit for making the arc lamp commercially available was given to Mr. Charles Brush, who invented the controlling apparatus for regulating the feeding of the carbons as well as the automatic cut out. Mr. Rogers deplored the fact that the improvements in arc lamps have not kept pace with other electrical apparatus. Not a single idea of merit has been added to it in 20 years and it is the most inefficient electrical appliance on the market. The interior is a mass of springs, cog wheels and sliding rods which require constant attention to keep in order. The useful length is only one-third its total length; a large portion of the carbons have to be thrown away; and while the slipping past each other of the carbons has always been one of the greatest sources of annoyance, no successful appliance has been perfected for its prevention.

A paper on "Electrolysis," by Capt. Wm. Brophy, detailed the injury done to gas and water pipes and the metallic insulation of underground wires by the ground return current of electric railways. As yet no insulation has been placed upon the market which resists this action. The methods of welding the rails and the use of metallic bond had, he thought, entirely failed. He concluded that there is but one way out of this difficulty and that is by using a wire return. This is proved by the fact that there is no trouble from electrolysis where such a system has been put in use. In conclusion he said that if electric lighting companies are obliged to go under ground and obliged to use lead covered cables, injustice to those engaged in the electric lighting business, the authorities should protect their property after compelling them to place it under ground.

Mr. Albert A. Carey read a paper on "Steam Boilers, Their Equipment and Management." He believed that electric lighting stations are full of poor boilers, and that central station men, as a rule, neglect this part of the plant. In the purchase of boilers, he advised, since a boiler is not equally suited to all conditions, the employment of a competent mechanical engineer able to decide upon the best equipment under the existing conditions. Mr. Carey believed that high-pressure boilers, in which the pressure could be maintained at 300 lbs. and reduced to 80 lbs. by reducing valves, are the most economical. This gives constant pressure, requires less space for boilers and furnaces, and less expense not only in first cost but in operating. For central stations with great variation in load he advised the mechanical automatic-induced draft, which, as it were, banks the fires when the load is light and drives them when it is heavy. The installation of induced draft apparatus does away with tall chimneys and is more valuable in that greater draft can be obtained than is possible with the tallest chimney. It may also be applied where the existing chimney is out of proportion to the size of the plant. The site of the boiler plant should be a matter for careful consideration; if possible it should be on a water front or railway to facilitate the handling of coal. Provision should be made for storing the coal and protecting it from the weather. In closing the paper described the various feed water filters on the market, both mechanical and chemical, and the different forms of mechanical stokers. Especial attention was called to the fact that the quality of the coal to be used does not in any way affect the choice of a boiler; a large steam space is not an essential feature of a boiler, but a large water capacity is to be preferred.

On Thursday evening the Association accepted the invitation of the Crocker-Wheeler Electric Co. to visit its works, and was taken by special train to Ampere, N. J.

The following officers were elected for the ensuing year: Mr. Frederic Nichols, Toronto, President; Mr. H. J. Clay, Philadelphia, first Vice-President; J. J. Burleigh, Camden, N. J., second Vice-President. Executive committee: A. J. De Camp, J. A. Seeley, A. M. Young, H. A. Wagner.